US Army Corps
of Engineers®

Independent Validation Review of the May 2006 Estimate at Completion

for the

Hanford Waste Treatment and Immobilization Plant Project

Prepared for:

U.S. Department of Energy, Office of River Protection

Office of Environmental Management and Office of Engineering and Construction Management

Prepared by:
U.S. Army Corps of Engineers
Walla Walla District

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Independent Validation Review of the May 2006 Estimate at Completion

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EXECUTIVE SUMMARY

INTRODUCTION

In December 2000, the U.S. Department of Energy (DOE), Office of River Protection (ORP), awarded Bechtel National Incorporated (BNI) a cost-plus incentive fee contract for the Hanford Waste Treatment and Immobilization Plant (WTP) project. The Hanford WTP project was established to design, build, and commission a plant to immobilize mixed (radioactive and hazardous) waste stored in underground tanks at the DOE Hanford site near Richland, Washington. The waste accumulated between 1944 and 1989 when the Hanford site produced plutonium and other nuclear materials for national defense.

DOE, Office of Environmental Management, in collaboration with the Office of Engineering and Construction Management, authorized ORP to prepare a memorandum of agreement and to fund the U.S. Army Corps of Engineers (USACE), Walla Walla District, to conduct independent reviews of the Hanford WTP project. A Statement of Work (SOW) was prepared that provides authorization for this independent validation review (IVR) of the WTP May 2006 Estimate at Completion (EAC).

The USACE validation review began with the December 2005 EAC while awaiting the submittal of the May 2006 EAC by BNI. The IVR Team reviewed the December 2005 EAC to gain an understanding of the processes and methodology used by BNI to prepare cost, schedule, and risk elements of the estimate. The Team then evaluated the May 2006 EAC to determine if it had been prepared in accordance with those processes and performed appropriately, efficiently, and effectively to contribute to the success of the project. Evaluation of the May 2006 EAC included analyses of changes from the December 2005 EAC submittal and permitted the review to be conducted within a compressed time period. The May 2006 EAC incorporates two recent technical reviews, the External Flowsheet Review Team (EFRT 2006) and External Review Team (ERT 2006). Based on the revised funding profile, the May 2006 EAC provides a full bottom-up cost estimate for five distinct facilities, i.e., Pretreatment, Low-Activity Waste, High-Level Waste, Balance of Facilities, and Analytical Laboratory.

During the review period, DOE-ORP and BNI organizational and staffing changes have been initiated in an effort to improve project management processes. The IVR Team noted that many of these improvements were the result of joint discussions among the IVR Team, DOE-ORP, and BNI. Other improvements were the result of initiatives undertaken by DOE-ORP and BNI from influences outside of the IVR effort. This report highlights some of these changes; however, the Team emphasizes that benefits from these efforts have yet to be realized.

VALIDATION PROCESS

For the purposes of this IVR, "validation" is defined as a determination of a reasonable cost estimate, schedule, and risk analysis for the WTP project. EAC is defined as the current estimated cost and schedule and risk for the WTP. The EAC includes project costs incurred to date and estimate-to-complete (ETC) costs, also recognized as "to-go" costs. The primary focus of this validation effort was evaluation of ETC cost, schedule, and risk. Project costs incurred to date were only evaluated in terms of their historical performance and the effects of that performance on the ETC costs.

VALIDATION RESULTS

On June 1, 2006, BNI provided DOE-ORP with the May 2006 EAC, which presented a total project cost (without contractor fee or potential incentives) at $11.553 billion and a contract completion date of August 2019. BNI indicated in the EAC submittal that these estimates with contingency allow for an 80 percent confidence level. This EAC, which did not include any fee or further incentives, was the basis for the IVR Team validation results presented in this report.

The IVR Team validates the May 2006 EAC as presented by BNI with two qualifications:

1. Validation is qualified with the inclusion of $650 million in net (additions/deductions) adjustments (table ES-1).
2. Validation is qualified with the addition of 3 months of schedule contingency.

The IVR Team recommends $12.203 billion as the WTP EAC cost excluding any potential fee or incentives, with a corresponding schedule completion date of November 2019. As shown in table ES-1 below, this validated EAC figure includes a base cost of $9.11 billion and its associated contingency of $1.731 billion. This figure also includes a separate Technical and Programmatic Risk Assessment (TPRA) contingency component of $1.366 billion, bringing the total validated EAC contingency figure to $3.1 billion.

Of the $12.203 billion validated, $2.74 billion has been expended through fiscal year (FY) 2005, leaving approximately $9.5 billion remaining as "to-go" costs or ETC. The $9.5 billion includes a base cost of $6.36 billion with the remainder as contingency and TPRA. When compared with this "to-go" base cost estimate, the validated base cost contingency represents 27 percent of the ETC base cost while the TPRA contingency represents 22 percent of the ETC base cost. The IVR Team's validated total contingency figure, therefore, represents an approximate 49 percent addition to the validated ETC base cost.

The IVR Team's validated cost value and revised completion date support an 80 percent confidence level included in the BNI submittal. The review process did identify findings and observations regarding cost, schedule, risk, EAC development tools, and management processes.

A "Finding" is categorized as a clear statement of deficiency with respect to practices, regulations and codes, orders, requirements, and agreements. A "Finding" requires an action to be taken for the project to have a reasonable expectation of achieving its documented objectives. This IVR report contains eight findings that are uniquely identified by number and accompanying recommended actions. They are discussed on the following pages as well as in the respective sections of this report.

An "Observation" is defined as an area of concern in the judgment of the IVR Team. This IVR report also lists observations, which have less impact to the project than findings, and may or may not have recommended actions. They are discussed in the respective sections of this report.

Table ES-1 illustrates the IVR Team's validation results.

Table ES-1. IVR Team Validation Results Summary

	May 2006 EAC	IVR Team Validation Net Adjustments	IVR Team Validated EAC
Base Cost	$8.786 B	$320 M	$9.106 B
Contingency	$1.651 B	$80 M	$1.731 B
TPRA[1]	$1.116 B	$250 M	$1.366 B
Total Cost	$11.553 B[2]	$650 M	$12.203 B[2]
Schedule	Aug 2019	3 months	Nov 2019

[1] Technical and Programmatic Risk Assessment.
[2] These figures do not include any fee or potential incentives.

The integration and structure of the IVR Team validation effort provided focus in four key areas: Cost Validation, Schedule Validation, Risk Validation, and assessment of Management Processes. The following represents a synopsis of the findings and respective recommendations found in this report corresponding to the four key areas.

Cost Validation

The IVR Team validates the base cost elements of the May 2006 EAC with the following findings and net adjustment (see section 3.0 of this report):

Finding 1: The IVR Team concludes that BNI craft labor estimates are adequate in all areas except electrical, piping, and instrumentation commodities. The IVR Team recommends a net positive adjustment of $320 million to the May 2006 EAC.

Finding 2: The lack of data traceability within the EAC demonstrates a weakness in methods used to generate and organize the estimate basis and development data. The IVR Team recommends that BNI establish an electronic interface between its multiple data development and control systems, eliminating the requirement for extensive manual loading of data, to increase the operating ease and competence of the system as a whole. Effective integration of data systems provides a more timely response to project cost and schedule impacts.

Schedule Validation

The IVR Team validates the schedule as an adequate basis for the May 2006 EAC (see section 4.0 of this report). Team concerns, identified to BNI during the review and validation process, were addressed and resolved, but significant improvements to the schedule are required to make it a more meaningful management tool. The 3-month addition to schedule contingency presented in Table ES-1, IVR Team Validation Results Summary, is included in the following risk validation discussion.

Risk Validation

The IVR Team validates the risk analysis elements of the May 2006 EAC with the following net adjustment and finding (see section 5.0 of this report):

Net Adjustment: The IVR Team completed confirmatory risk and contingency assessments of the May 2006 EAC. Consistent with BNI's approach to risk analysis, the IVR Risk Team analysis techniques and resulting contingency adjustment calculations were all performed against project direct costs as well as overhead and hotel costs. The Team modified and updated BNI risk results. The IVR Team recommends the net addition of $48 million to the base cost contingency and 3 months be added to the duration of the WTP schedule with $32 million additional schedule contingency for a total addition of $80 million (as shown in table ES-1).

Finding 3: In the May 2006 EAC, BNI plans to use non-jurisdictional labor for non-technical employees for Startup, Commissioning, and Training (SCT). BNI may be required to utilize workers falling under the local union labor agreement, resulting in higher costs and schedule extensions. The IVR Team recommends a $250 million addition to TPRA contingency associated with the proposed use of non-jurisdictional labor for SCT technical support.

Validation Conditions

Validation conclusions, including associated findings and adjustments presented in this report are based on a FY 06 funding level of $490 million and an assumed stable funding level of $690 million in FY 07 into the out years. Validation is also based on the current EAC project strategy and scheduled completion of the five facilities.

Though not tasked with validating a WTP Performance Measurement Baseline (PMB), the IVR Team recognizes that there were expectations that the May 2006 EAC would be used as a PMB. It is clear from the May 2006 EAC documents that BNI intends to use that EAC as the new PMB, and DOE-ORP, in its June 2006 Quarterly Performance Review, compares current WTP performance to the May 2006 EAC.

Validation of the May 2006 EAC does not constitute certification of the EAC as a PMB for the following reasons:

- The EAC does not meet PMB definition requirements:

> "An approved integrated scope, schedule, and cost plan for the project work against which project execution is compared to measure and manage performance. Technical and quality parameters may also be included." (Project Management Institute 2004.) The baseline must capture the entire technical scope of work, consistent with contract schedules, and must have adequate resources assigned. Valid cost and schedule data depend on developing a meaningful baseline for controlling internal performance and reporting valid contract status information to the Government. Proper maintenance of the baseline prevents performance measurement against an outdated or unauthorized plan. Project managers are responsible for ensuring the accuracy of the baseline.

- A PMB consists of defined scope, cost, and schedule linked using a common Work Breakdown Structure (WBS).
    - The current WTP WBS and supporting control accounts are not formally established to the level required for adequate management control and progress reporting.
    - It is not possible to determine cost associated with each schedule activity in the present EAC because not all resources are loaded into the Level 4 schedule.
    - Traceability is weak throughout the current EAC. All activities/cost elements must be tied to the WBS, fully integrated, and traceable from supporting details to higher levels of the EAC.

- A PMB is required to establish a working Earned Value Management System (EVMS) and maintain the change control process and technical configuration control. The current EAC was not developed by applying the change control process to the March 2003 baseline at the lowest level of detail. It was the product of a (new) bottom-up estimate and presents comparison to the December 2005 estimate.

- WBS elements should be measurable such that reported performance is based on work physically completed, not money spent or hours expended. The May 2006 EAC schedule activities are not fully resource loaded, precluding actual measurement of earned value.

The review process identified improvements to EAC development tools and management processes that could be used by DOE-ORP and BNI management teams to establish a suitable PMB and EVMS. These improvements are described throughout the cost, schedule, risk, and management process sections of this report.

Validation of the May 2006 EAC does not constitute certification of the EAC as a part of an EVMS. The proposed EVMS is undergoing a formal certification process that is separate from this IVR.

Validation does not constitute Government approval of any potential Requests for Equitable Adjustment (REA). REA issues are resolved through other formal processes that are separate from this IVR.

Management Processes

The USACE SOW for this effort states, "Provide recommendations where possible for improvements, which could affect cost and schedule performance, this would include a rationale for any recommendations and quantifying their impact on cost and/or schedule." Further, during testimony on April 6, 2006, Chairperson, Representative David L. Hobson of the Energy and Water Development, Subcommittee of the House Appropriations Committee, requested constructive input and recommendations to improve the WTP project. As a result, an IVR Management Processes Team, comprised of senior-level personnel, was included in the EAC validation effort to evaluate WTP management processes, both on the part of BNI and DOE-ORP.

The Team reviewed organizational structures, management techniques, and the use of project and management tools for an assessment of the leadership and oversight of the WTP project. Although the IVR Team validates the May 2006 EAC, the Team also evaluated management effectiveness and its relationship to historical and potential cost and schedule growth (see section 6.0 of this report).

WTP ESTIMATED COST AND SCHEDULE HISTORY

In the past 6 years, scope, cost, and schedule growth have continued on this first-of-a-kind, complex project. EAC values demonstrating this growth are presented in table ES-2.

Table ES-2. WTP Estimated Cost and Schedule History

	Offerors Proposed EAC December 2000	March 2003 EAC (Baseline)	April 2005 EAC	December 2005 EAC	May 2006 EAC
Base Cost	$3,465 M	$4,856 M	$7,294 M	$7,736 M	$8,786 M
Contingency	$500 M	$550 M	$700 M	$1,041 M	$1,651 M
TPRA[1]	$0 M	$100 M	$900 M	$1,760 M	$1,116 M
Total Cost[2]	$3,965 M	$5,506 M	$8,894 M	$10,537 M	$11,553 M
Schedule	July 2011	July 2011	July 2011	May 2017	August 2019
Design Complete	5-10%	<40%	60%	68%	68%

[1]Technical and Programmatic Risk Assessment.
[2]Costs do not include contractor fee.

The May 2006 EAC of $11.553 billion represents an increase of $7.588 billion, or 191 percent, over the original estimate (Offeror's Proposed) of $3.965 billion. The IVR Team recognizes that the WTP is a first-of-a-kind, complex project and understands the complexities involved with estimating cost and schedule. However, previous reports

(provided in section 2.2.2) cite a faulty initial estimate and optimistic treatment of uncertainty and risk (as shown in table ES-2, only $500 million in Contingency and $0 in TPRA at December 2000). It is evident that design, contingency, and TPRA evolution have also occurred. The May 2006 total reflects $2.7 billion in Contingency and TPRA. Major technical, regulatory, and programmatic changes include the following:

Technical

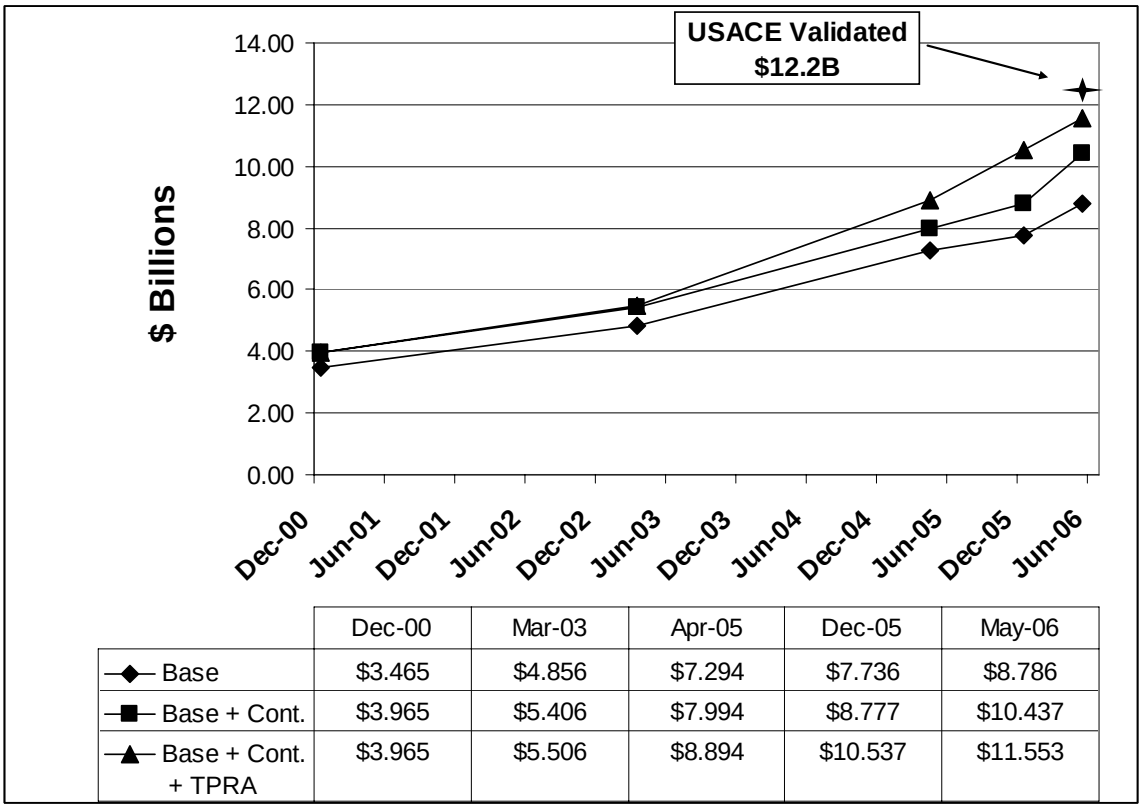
- Design changes required to overcome unplanned technical challenges such as non-Newtonian fluid mixing, control of hydrogen in piping and ancillary vessels, and remote operability and maintainability of equipment.
- Changes to address modified seismic design criteria.
- Increases to the treatment capacity of the plant. Throughput of the high-level waste glass-making process was quadrupled and the capacity of the pretreatment processes was increased by 40 percent.
- Changes to address and resolve design deficiencies.

Regulatory and Programmatic

- Changes to funding streams.
- Increases to contingency and TPRA due to improved focus on and reporting of risk assessment.

The facts that surround the increases to cost and schedule experienced on this project can be found in other reports, such as the Hanford WTP Logistics Management Institute (LMI) After-Action Fact-Finding Review (2006). The 1981 Rand Report refers to five key factors for cost growth: Scope Changes, Inflation/Escalation, Regulatory Changes, Bad Luck, and Management Practices. The EAC contingency and TPRA development attempt to capture possible Scope Changes, Inflation/Escalation uncertainty, and to some degree Bad Luck. It is unclear whether they fully capture the effects of Regulatory (and funding) Changes and Management Practices related to the WTP and its historical growth. With the exception of Management Practices, the factors that contribute to cost growth cited by the Rand report (1981) are considered “external” and impose a culture of reaction by stakeholders. Management Practices, however, is the one internal project factor that allows for a proactive capability and can directly influence reaction to the others. Management Practices at the WTP encompass activities shared by DOE-ORP, DOE Headquarters (HQ), BNI, and other external stakeholders, which may have fostered a reactionary culture and inhibited project management effectiveness, as outlined further in this report.

Figure ES-1 illustrates the USACE validated EAC of $12.2 billion (excluding potential fee and other incentives) in comparison to the cost history for the WTP. The USACE value demonstrates the trend for higher EAC values with each subsequent submittal.



	Dec-00	Mar-03	Apr-05	Dec-05	May-06
Base	$3.465	$4.856	$7.294	$7.736	$8.786
Base + Cont.	$3.965	$5.406	$7.994	$8.777	$10.437
Base + Cont. + TPRA	$3.965	$5.506	$8.894	$10.537	$11.553

Figure ES-1. **WTP EAC Cost Curves**

Individual and compounding causes for cost and schedule growth continue to be argued among the experts and speculators. However, the IVR Management Processes Team asserts that management practices, while overshadowed by other widely reported impacts (Technical, Regulatory, and Programmatic), have profound influence on the outcome of the WTP project in terms of cost, schedule, and ultimate completion.

Numerous management improvement efforts (see section 2.2.3) have been initiated by both DOE-ORP and BNI over the past months in an effort to curb these historical growth trends. DOE-ORP has also directed full application of DOE Order 413.3 including the requirement for application of a certified EVMS. The preparation, review, and certification process for EVMS is now underway. Since these initiatives are recent, measured improvements have yet to be demonstrated. This leaves concern that cost and schedule growth may continue above the USACE validated figure of $12.2 billion without near-term adoption of rigorous management and project control processes. In addition, under a constrained funding situation, any increase in cost may translate to additional schedule growth. Cost curtailment, cost avoidance, and continuous process improvement must become part of the standard operating procedures at the WTP. Several findings and observations are presented along with relevant recommendations intended to support optimization of DOE-ORP and BNI Project Team effectiveness in controlling potential cost and schedule growth.

IVR Management Processes Team findings include:

Finding 4: The current WTP contract established between BNI and DOE-ORP does not provide for optimum management of the project at the site. Weak language and lack of clear contract definitions results in ambiguity of contractual roles and responsibilities. The IVR Team notes that DOE-ORP is currently pursuing contract revisions. The IVR Team recommends that proposed contract changes be reviewed and approved by DOE-ORP counsel and DOE-HQ prior to implementation. Implementation should take place as soon as possible to enable DOE-ORP to effectively manage and clearly articulate required contractor milestones, desired timely achievements, and any appropriate incentives and penalties. The Team also recommends that responsibility assignment matrices and support details be communicated at various levels of both DOE-ORP and BNI organizations.

Finding 5: The baseline (technical scope, cost, and schedule) has not been adequately established. The IVR Team recommends that all design studies and decisions be aggressively pursued and potential REA resolved. Further, a disciplined process for evaluation and disposition of all potential future scope changes needs to be adhered to by representative members from DOE-ORP, BNI, and other relevant stakeholders. Decisions must be timely, with adherence to established processes and procedures with accountability for undesired action or inaction.

Finding 6: The WTP project lacks an effective change control process. The IVR Team recommends all changes and potential disputed issues be resolved within a reasonable timeframe, based on an established process, and implemented on both sides (government and contractor). The IVR Team recognizes that the revised Baseline Change Control process, dated August 7, 2006, attempts to remedy this situation. DOE-ORP should be recognized as an early partner in notifications from BNI concerning potential cost and schedule impacts. Further, as the owner and operator, DOE-ORP must be the recognized contracting authority and held accountable and responsible for timely disposition of potential project impacts and disruptions, including notification to DOE-HQ and completion of necessary action items.

Finding 7: WTP project performance is not being actively managed with an effective EVMS. After 5 years, Unilateral Modification No. 55, December 2005, resulted in the requirement for EVMS. The IVR Team recommends a certified EVMS be implemented for use on the WTP project as quickly as possible. That effort must actively include DOE-ORP involvement. The IVR Team recognizes that this program is scheduled for Defense Contract Management Agency certification review in November 2006 with a certification objective by May 2007.

Finding 8: DOE-ORP needs a stronger position with regard to ownership and management of all contingency. The IVR Team recommends establishing DOE-ORP ownership of all contingency. Ownership and management of all contingency establishes DOE-ORP with contract control authority. This also ensures that BNI and DOE-ORP are actively monitoring trends, costs, scope, and schedule to fund appropriate changes. The IVR Team recognizes that DOE-ORP has begun pursuing

resolution of this concern within the revised Standard 1 of section C of the proposed WTP contract. At the time of this report, this concern remains unresolved.

IVR TEAM OBSERVATIONS

This report contains 20 primary observations that are not included in this Executive Summary. Those observations, with explanations for their basis and resulting recommendations, are presented in detail in the following sections of this report. There are additional general observations contained in the appendixes, which are considered less critical and are not discussed in this report.

ALTERNATIVES FOR CONSIDERATION

On April 6, 2006, during testimony to the Energy and Water Development Subcommittee addressing WTP performance and out-year funding, Subcommittee Chairperson, Representative David L. Hobson, requested constructive thoughts "to make this thing work better."

In response to that request and consistent with IVR SOW requirements to provide recommendations for improvements, section 6.7 of this report includes life cycle and contract administration alternative analysis recommendations for consideration by WTP stakeholders. The IVR Team recommends DOE-ORP consider comprehensive program risks, including the Tank Farm, WTP construction, operation, life-cycle costs and schedules, and study alternatives such as those recommended.

SECTION 1.0 - INTRODUCTION

1.1 Background

In December 2000, U.S. Department of Energy (DOE), Office of River Protection (ORP), awarded Bechtel National Incorporated (BNI) a cost-plus incentive fee (CPIF) contract for the Hanford Waste Treatment and Immobilization Plant (WTP) project. The scope of the Hanford WTP project is to design, build, and commission a plant to immobilize mixed (hazardous and radioactive) liquid waste stored in underground storage tanks at the DOE Hanford site near Richland, Washington. The waste accumulated between 1944 and 1989 when the Hanford site produced plutonium and other nuclear materials for national defense. The 53 million gallons of tank waste is Hanford's most serious cleanup problem. The radioactive material is stored in 173 aging steel and concrete underground tanks. Sixty-seven of the tanks are known or are suspected to have leaked, releasing 500,000 to a million gallons of waste into the ground, threatening the groundwater underneath the tanks. The new plant will incorporate the waste into a chemically immobile glass that is environmentally safe and stable through a process called vitrification. Major scope items include:

- Design large-scale facilities to pretreat the waste and separate it into high-level waste (HLW) and low-activity waste (LAW), mix the waste with molten glass waste-forming chemicals in special furnaces, and place it in stainless steel containers.

- Construct three nuclear facilities: Pretreatment (PT) facility, LAW facility, and HLW facility for pretreatment and vitrification, along with substantial supporting facilities.

- Commission the facilities to demonstrate that they meet production and efficiency criteria.

1.2 Scope

DOE, Office of Environmental Management, in collaboration with the Office of Engineering and Construction Management, authorized the ORP to prepare a memorandum of agreement and to fund the U.S. Army Corps of Engineers (USACE), Walla Walla District, to conduct independent reviews of the WTP project. From this memorandum of agreement, a Statement of Work (SOW) was prepared. The SOW specifically states, "Review the Updated 2005 Estimate at Completion and Potential Contract Modifications," which is the authorization for this independent validation review (IVR) of the WTP May 2006 Estimate at Completion (EAC).

1.3 IVR Team

USACE assembled a team of experienced personnel and nationally recognized experts to validate the May 2006 EAC. USACE assigned Corps personnel to the effort and

acquired the services of one of the top cost engineering firms in the country specializing in cost management and scheduling solutions. The firm, Project Time & Cost, has extensive experience with large nuclear projects.

The IVR Team was comprised of 29 members representing extensive experience in major engineering and construction projects in both the public and private sectors. The Team consisted of engineers from cost, civil, mechanical, electrical, structural, and nuclear disciplines. A specific effort was made to obtain individuals having expertise with nuclear facilities and the Hanford site. Team credentials include cost engineering, contracting, procurement, scheduling, risk and contingency development, nuclear engineering, nuclear facility construction, contract management, and executive management. Biographic summaries for each of the members of the team are provided in Appendix A, Independent Validation Review Team.

The IVR Team was comprised of four subject-specific teams, assembled to facilitate the validation effort with the assistance of USACE personnel:

- IVR Cost Team.
- IVR Schedule Team.
- IVR Risk Team.
- IVR Management Processes Team.

1.4 General Team Methodology

The USACE validation review began with the December 2005 EAC while awaiting the submittal of the May 2006 EAC by BNI. The IVR Team reviewed the December 2005 EAC to gain an understanding of the processes and methodology used by BNI to prepare cost, schedule, and risk elements of the estimate. The Team then evaluated the updated May 2006 EAC to determine if it had been prepared in accordance with those processes and performed appropriately, efficiently, and effectively to contribute to the success of the project. Evaluation of the May 2006 EAC included analyses of changes from the December 2005 EAC submittal and permitted the review to be conducted within a compressed time period. The May 2006 EAC addresses two recent technical reviews, the External Flowsheet Review Team (EFRT 2006) and the External Review Team (ERT 2006). Based on the revised funding profile, the May 2006 EAC provides a full bottom-up cost estimate for five distinct facilities, i.e., PT, LAW, HLW, Balance of Facilities (BOF), and Analytical Laboratory (LAB).

1.5 Summary of Findings, Recommendations, and Observations

This IVR report contains eight findings identified by finding numbers and accompanying recommended actions. This IVR report also lists observations, which have less impact to the project than findings, and may or may not have recommended actions. Details on

IVR Team findings, recommendations, and observations are provided in the main body of this report and are addressed in a Corrective Action Plan. The Corrective Action Plan in appendix B is provided to assist DOE-ORP in tracking response to the findings and observations. Additional "general observations" are contained in the appendixes, which are considered less critical and can be considered for project improvements. These general observations are not discussed in the body of this report.

1.5.1 Review Resources

The IVR Team participated in approximately 400 formal group and individual meetings and reviewed 576 formal documents. Appendix C contains references cited in this report.

1.5.2 Definitions/Acronyms

This report is also supported with Appendix D, Definitions. Appendix D provides a key terms dictionary and explanation of all abbreviations that appear in the report.

1.6 Subject-Specific Team Methodologies

The IVR Cost, Schedule, and Risk Teams each developed a team-specific review methodology for the validation review. Details of each subject-specific team's methodology are included in the team-specific appendixes to this report:

- Appendix E, Cost Validation Review.
- Appendix F, Schedule Validation Review.
- Appendix G, Risk Analysis Supplemental Data.

The IVR Management Processes Team performed a comprehensive evaluation of formal documents, including management-related correspondence, memorandums, issued orders and guidance, and industry protocols to determine the level of compliance with expected and established standards.

SECTION 2.0 - DEVELOPMENT PROCESS IMPROVEMENTS

2.1 Cooperative Approach

The IVR Team review effort included DOE Headquarters (HQ), DOE-ORP, and BNI as vital participants, recognizing that cooperation helps to eliminate potential misunderstanding or misinterpretation of the review documents, management tools, and processes. This cooperative approach fostered better communication, a shared knowledge, and a more accurate validation of the May 2006 EAC. The IVR Team recognizes and appreciates the considerable effort that was required on the part of both BNI and DOE-ORP in cooperating as necessary for this review.

Since the start of the IVR Team EAC review in October 2005, Team interactions, discussions, and expressed concerns have resulted in what the Team believes to be a renewed focus on contract management practices and processes for the WTP project. Both DOE-ORP and BNI have begun implementing staffing and process changes in pursuit of improved project control. The IVR Team believes this report would be incomplete if it did not acknowledge these efforts.

2.2 Project Progress

2.2.1 Background

The USACE independent review report issued in May 2005 included 36 findings with accompanying recommendations and more than 50 specific observations regarding the April 2005 EAC.

DOE-ORP evaluated those findings, recommendations, and observations and determined that DOE-ORP should address 13 of the findings with associated recommendations. The remaining 23 findings and recommendations, along with the majority of the report observations, were provided to BNI, who was directed to respond within the upcoming December 2005 EAC. DOE-ORP personnel developed a COE Corrective Actions for BNI spreadsheet to coordinate findings, recommendations, and observations from the report to activities that were the responsibility of either DOE-ORP or BNI.

BNI responded as requested in the December 2005 EAC, Volume 1, Section 11. In section 11, a specific response was provided for each assigned recommendation or observation. BNI accepted the report material and agreed to include responses to the majority of the recommendations and observations in the December 2005 EAC. The remainder was addressed either in the May 2006 EAC or through an alternate explanation.

The IVR Team, a DOE-ORP representative, and BNI staff reviewed all findings with associated recommendations included in the spreadsheet and determined the actions indicated were complete to the satisfaction of DOE-ORP.

2.2.2 Other Concurrent Studies

Related studies were ongoing during the IVR Team review. Formal reports were issued for each study, including:

- Burns and Roe Enterprises, Incorporated - Final Deliverable - *Selected Review of the Bechtel National, Inc., Estimate At Completion for the Waste Treatment and Immobilization Plant*, January 2006. Burns and Roe Enterprises, Inc. was hired to review and evaluate selected cost estimate portions of the September 2005 EAC for the LAW, BOF, and LAB.

- Logistics Management Institute (LMI) Government Consulting – Report DE535T1, *Hanford Waste Treatment and Immobilization Plant Project, After-Action Fact-Finding Review*, January 2006. DOE, Office of Engineering and Construction Management, directed LMI to perform an after-action fact-finding review of the project cost and schedule delays.

- EFRT – Technical Scope Review, *Comprehensive Review of the Hanford Waste Treatment Plant Flowsheet and Throughput,* March 2006. The EFRT was hired through BNI and was comprised of independent technical experts from throughout the nation's chemical and nuclear industry. The EFRT was tasked by BNI to provide a comprehensive review of the process capability of the WTP to meet the throughput requirements as stated in the contract with all representative feeds. It was also tasked to evaluate the adequacy of the process technology transformation to the engineering application, review system interfaces, and evaluate overall system capability.

- ERT - Cost/Schedule Review, *Comprehensive Review of the Hanford Waste Treatment Plant Estimate at Completion*, March 2006. The ERT Cost and Schedule group was also hired through BNI to evaluate the December 2005 EAC cost, schedule, and risk development. The ERT review was a short review period performed at a higher summary level than the IVR Team.

2.2.3 Project Management Changes

In an effort to control project costs, a memorandum from the Assistant Secretary for Environmental Management, James A. Rispoli (Rispoli Memorandum 2005) stated, "Actions for Waste Treatment Plant Project" authorizes additional DOE-ORP staffing, contract incorporation of DOE Order 413.3, DOE Manual 413.3-1, and a fully ANSI/EIA[1] 748-A-1998 compliant Earned Value Management System (EVMS). In response to such authorization, changes are underway; however, any benefits have yet to be determined.

[1] American National Standards Institute/Energy Information Administration.

2.2.3.1 DOE-ORP Changes

During the IVR review process, DOE-ORP and BNI began making further project adjustments. DOE-ORP is implementing the actions in the Assistant Secretary's Memorandum (2005) including the contract requirements, the authorized organizational restructuring, and additional personnel for contract management. Likewise, BNI is initiating adjustments to the personnel and management systems applied to the WTP.

Staffing Changes

The following list indicates the actions being taken by DOE-ORP to upgrade staff and enable greater contract and project control oversight:

- Hiring has been completed for two senior level EVMS project control personnel, and through internal transfer, a third addition was made to the EVMS staff.
- Recruitment has commenced for three senior project managers to assume responsibility for major subprojects.
- A realignment of Federal WTP staff is currently underway to provide a better focus on the Design and Engineering group and the planned ramp-up of construction activities.
- Contract administration staff has been increased by the addition of a senior level procurement manager. In addition, a contracts attorney and four additional contract management specialists have been hired and are onboard.
- The engineering organization has recruited a risk management specialist to focus on external project risks and integration with the Tank Farm Project.
- The Senior Safety Oversight Program has been strengthened with specialized training programs. Additional emphasis is being placed on functional area qualification training and certification.

Management System Changes

The following list includes management changes being implemented by DOE-ORP:

- DOE Order 413.3 and DOE Manual 413.3-1, addressing program and project management, are being incorporated into the contract. The contract was modified with Modification No. 55 in November 2005, requiring the contractor to follow DOE Order 413.3 and DOE Manual 413.3-1.
- The contract with BNI has been modified with Modification No. 55 in November 2005 to add the ANSI standard for EVMS systems to improve

accuracy in reporting. This modification requires the contractor to utilize an EVMS, which is certified per the ANSI standard.

- Complete pre-negotiation strategies for contract negotiations with BNI are being prepared.
- All DOE-ORP management plans and procedures are being updated to reflect higher levels of contractor oversight.
- A new support contract arrangement is being developed to provide WTP with a direct "owner/operator" perspective.
- An explicit definition for the meaning of "design authority" is being developed within the context of the contract.
- Technical provisions in the contract are currently being revised. The objective of this effort is to clarify plant functional and performance requirements, add specific requirements for project control tools, and add schedule requirements that ensure a higher quality resource-loaded schedule.
- The Project Execution Plan, Contract Management Plan, and other top-level management documents for the WTP are being revised. This includes the very recent revision of the Baseline Change Control (BCC) document issued August 7, 2006.
- As requested by U.S. Congress, new quarterly congressional reporting requirements have been initiated.
- DOE-HQ has increased management and technical oversight of the WTP project.
- Definitive instructions for revising EAC estimates have been provided including separate submittals for individual claims or Requests for Equitable Adjustment (REAs).
- Establishment in April 2006 of a Senior Management Integration Team that provides executive oversight of activities carried out by the Tank Farm contractor and WTP contractor.

2.2.3.2 BNI Changes

The following represents a number of staffing, organization, project, and control concerns being addressed and implemented by BNI since the IVR began:

- At the request of DOE-HQ, BNI has completed two external reviews of the WTP project by leading industry experts.

  - One review group, the EFRT, evaluated the process flowsheet to provide an outside opinion regarding plant functionality (see section 2.2.2). All recommendations from that review are being evaluated, and it is anticipated that the 17 required actions would be implemented. The remaining 11 recommendations are being evaluated for possible implementation. Rough order of magnitude estimates for the resulting changes included in the May 2006 EAC are under 5 percent of total project cost.
  - The second external review group, the ERT, evaluated the December 2005 EAC. Recommendations were made to add additional contingency for Unknown-Unknowns common to first-of-a-kind facilities.

- BNI has made changes to the WTP project controls organization including bringing in a more senior manager and adding several staff positions.

- BNI is revising their Project Execution Plan and related EVMS procedures.

- BNI is preparing for certification review of their EVMS by the Defense Contract Management Agency (DCMA) in November 2006 with a certification objective by May 2007.

- BNI improved identification and management of technical and programmatic risks and prepared a new risk management procedure.

- BNI reorganized WTP project staff to emphasize functional alignment and to facilitate improved communication between discipline groups. Additional senior staff has also been added.

- BNI is in the process of realistically quantifying project risks and then allocating corresponding contingency.

- BNI is conducting reviews of its processes and procedures to assess project compliance with DOE Order 413.3.

SECTION 3.0 - COST REVIEW

3.1 Introduction

The IVR Cost Team reviewed the December 2005 EAC and associated supporting documentation in detail focusing on the following key cost areas:

- Direct Capital Cost.
- Design and Permitting.
- Procurement and Construction.
- Shared Services.
- Startup, Commissioning, and Training (SCT).

Supporting information was developed and backup material was assembled through a detailed review of various BNI estimating and planning documentation. Documentation includes: quantity development packages; engineering job hour estimate details; design drawings; 3-D model take-offs; engineering, progress, and performance reports; Bechtel Estimating Toolkit (BETK) capital cost estimating database; staffing plans; production performance data; performance monitoring systems; equipment tracking databases; applied escalation rates and basis; overhead structures; material and equipment unit pricing; purchase orders; construction performance tracking system; budgeted and historical unit installation rates; actual costs of material and equipment purchases; unit pricing methodologies; and labor wage rates. The IVR Cost Team also conducted extensive working level and supervisory level discussions and interviews, facility walk-downs, and BNI presentations of their various cost estimating tools and processes to secure a firm understanding of the EAC development process and input sources.

In addition to the comprehensive document review effort, the IVR Cost Team members coordinated their evaluation efforts with BNI personnel during the validation process between the December 2005 EAC and the May 2006 EAC submittals. The coordination resulted in the resolution of multiple issues, omissions, and discrepancies identified by the IVR Cost Team during the initial review. These included outdated material pricing, escalation inaccuracies, misalignments between design status and material quantities, and unit rate adjustment discrepancies. In most cases, BNI acknowledged and agreed to address these items or indicated that adjustments were already planned for the May 2006 EAC. While most items identified required upward cost adjustments to resolve, others represented excessive costs or quantities resulting in downward cost adjustments.

To validate the May 2006 EAC, the IVR Cost Team evaluated BNI's incorporation of these changes, analyzed cost variances from the December 2005 EAC for reasonableness, and developed a final net cost adjustment recommendation.

Review of the May 2006 EAC indicates recommendations provided by other project review teams, such as EFRT and ERT, were addressed and incorporated into the EAC.

The IVR Cost Team validates the May 2006 EAC cost estimate conditionally upon inclusion of a direct cost adjustment for insufficient craft unit rates in estimates for electrical, piping, and instrumentation commodities. The direct cost net adjustment is $320 million.

3.2 Methodology

The IVR Cost Team employed Pareto analysis methods to identify major EAC cost elements within each key cost area to be evaluated. The premise of the Pareto approach is that 80 percent of the estimate-to-complete (ETC) costs for a cost area typically occur in 20 percent of the cost elements within that area. This alleviates the need to evaluate 100 percent of the cost elements. As a result, a minimum of 80 percent of the major ETC costs were evaluated for each cost area reviewed. Figure 3-1 illustrates how this process was applied to the Direct Capital Cost area.

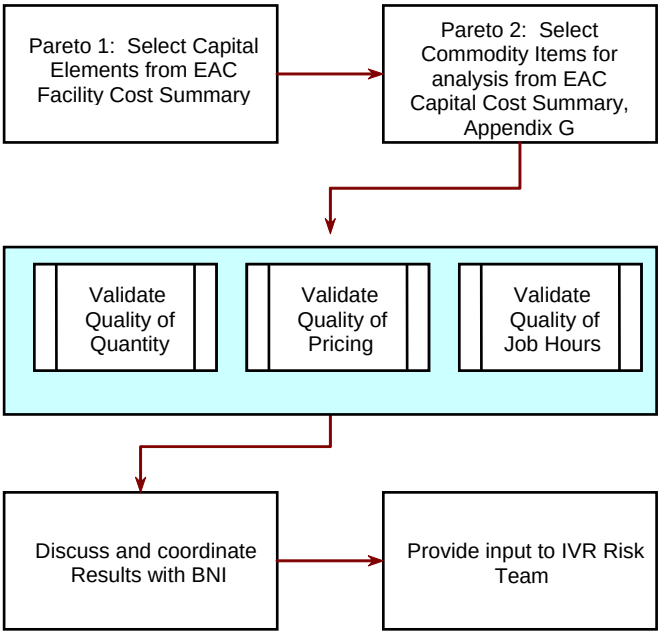


Figure 3-1. Capital Cost Element Selection and Evaluation

As a result of the Pareto approach, the IVR Cost Team selected cost elements for detailed evaluation within each of five key cost areas. The selections for the Direct Capital Cost area included most of the direct cost elements such as Plant Equipment and major commodities such as Concrete, Structural Steel, Piping, and Electrical. Design and Permitting selections included Production Engineering, and E&NS. Selections for Procurement and Construction include Field Work Non-Manual Labor and Acquisition Services (AS). Selected cost elements for Shared Services were spread among the five major organizations (i.e., Information Systems and Technology, Project

Administrative Services, Project Controls, Quality Assurance (QA), and Support Services). All cost elements for SCT were evaluated.

A brief description of the evaluation and validation methodologies used for each of the five cost areas are described in the following paragraphs (see appendix E for methodology details).

3.2.1 Direct Capital Cost

The IVR Cost Team analyzed the quality of commodity quantity estimates for nine commodities for accuracy in material take-off and for traceability of data from detail estimates to EAC summaries. Commodity material and equipment unit pricing quality was analyzed using published data, vendor information, experience from the current WTP design and construction, evaluator's judgment, and evaluation of BNI pricing development methods. The Team verified forecasting methods and developed alternate assembly unit rates for installation of certain commodity items to compare to rates depicted in the EAC.

3.2.2 Design and Permitting

The IVR Cost Team selected the Engineering estimate for the PT and HLW facilities for a full evaluation. A limited review of the LAW facility, BOF, and LAB was also performed as these facilities are near design completion.

The Team evaluated variations in methodologies and the historical basis that BNI used to estimate quantities of engineering deliverables and applicable unit production rates. The Team conducted a series of discussions with BNI engineering disciplines. Using the information from these discussions, the Team compared the results of estimates produced with recent WTP engineering performance. The Team also evaluated the job hour forecast projections for supervision, management, and ongoing engineering support of construction, testing, and commissioning phases.

3.2.3 Procurement and Construction

The procurement of labor and material is performed by the BNI AS organization. The estimate for AS includes staff labor and other direct costs (ODCs) such as travel, freight, and subcontract costs. AS developed their staffing plan by defining required work products (e.g., purchase orders, contracts, requests for proposal documents, etc.) and applying historic staff unit hour requirements from the WTP and other BNI projects.

The IVR Cost Team reviewed the estimated staffing plan and ODCs and compared the results with staffing on other complex projects. Indirect construction cost includes distributable materials, distributable craft labor, and field non-manual labor required to support direct installation of commodities. The Team evaluated indirect costs by comparing the ratios of indirect to direct cost with ratios on other complex projects.

The IVR Cost Team independently developed alternate craft unit installation rates for major commodities (piping, valves, electrical conduit, etc.) and reviewed historical unit installation rate performance factors for the WTP project and other nuclear facilities. These independently developed unit rates as well as BNI unit rate performance to date were compared with BNI estimated unit installation rates from the May 2006 EAC and a net adjustment recommendation was developed.

3.2.4 Shared Services

The Shared Services organizations selected for evaluation were Information Systems and Technology, Project Administrative Services, Project Controls, QA, and Support Services. The IVR Cost Team reviewed the detail in the December 2005 EAC, attended conferences with BNI Shared Services personnel, and compared the techniques for estimating the required staff with actual experience to date.

3.2.5 Startup, Commissioning, and Training

The IVR Cost Team evaluated SCT separately, because it involves unique operational aspects compared to construction and engineering and because most work is planned more than 5 years in the future (see discussion in section 3.6). The IVR Cost Team evaluated each step for necessity; determined whether the program included adequate safety precautions; evaluated the engineering and field staff estimated to be required to perform all SCT steps; anticipated difficulties associated with acquiring, training, and retaining qualified SCT staff; and evaluated the estimated durations anticipated to perform each step. The Team assessed the EAC and other data provided by BNI, attended relevant meetings, and performed numerous interviews with DOE-ORP and BNI personnel.

3.2.6 Escalation

Escalation is not an actual element of cost in an estimate but is rather a predetermined currency adjustment. BNI used escalation factors from Global Insights (a commercial escalation evaluation company) to develop escalation rates for the December 2005 EAC. BNI included their third quarter 2005 forecast information for labor and commodities to develop these escalation rates. Only direct ETC cost is escalated. Escalation is applied before other adders, overhead, and taxes. The IVR Cost Team reviewed the referenced escalation rate sources and evaluated BNI application of those factors throughout the EAC. The IVR Cost Team suggested adjustments to the escalation, which were eventually reflected in the May 2006 EAC.

3.3 Estimate at Completion Organizational Structure

BNI uses three project data organizational modes: Organizational Breakdown Structure, Work Breakdown Structure (WBS), and Resource Breakdown Structure.

- The Organizational Breakdown Structure organizes the project into functional organizations such as Management (controller, etc.), Project Controls (estimating, scheduling, etc.), Human Resources (programs, recruiting, etc.), and others.

- The WBS subdivides the project into successively more detailed work packages starting with Level 1 WTP project; then to Level 2 facility (PT, HLW, LAW, etc.); Level 3 (management, design, construction, commissioning, etc.); and Level 4 (working level detail). The WBS is a universally acceptable tool used to organize activity based estimate detail.

- The Resource Breakdown Structure organizes the project into resource categories such as BNI labor (home office salaries, home office staff, etc.), project office non-manual (project office lead, project office staff, etc.), construction craft (carpenter, iron worker, etc.), and others.

The IVR Cost Team focused on review of the project EAC cost estimate by WBS, investigating detailed work tasks for quantities, price, and installation. The review task was inhibited, because BNI does not use a structured estimating program, but rather combines an array of generally incompatible specific-use programs, spreadsheets, models, and methodologies. Information from the various sources is combined, with significant non-integrated transfer, in the Cobra© Deltek Systems Incorporated (Cobra) cost management software program that allows formation of nearly any combination of data into a report. As a result, BNI provides all the necessary data to develop an EAC in a multitude of reports that generally do not directly support a rollup to successively higher levels of WBS summary.

The EAC was presented in varied formats whose compatibility was not well documented, the IVR Cost Team met with BNI personnel in order to understand how the various data in the EAC were compiled and how the data supported specific rollup of summaries.

In a typical WBS hierarchy, elements lead to manageable project performance measurement and essential milestones. Working level elements should be measurable such that reported performance and progress and future planned work is based on work physically accomplished. Although BNI presented and referenced necessary supporting details, the EAC does not display hierarchical summaries that present the detail in logical form. A set of consistent hierarchical summaries is the basis of a clear and comprehensive periodic reporting system as well as for use to display an EAC. If BNI were to adjust their progress reporting development and presentation for future progress reporting requirements to include hierarchical summaries and eliminate non-integrated transfer of data, a new EAC would be automatically prepared each reporting period as a consequence of preparing the periodic report. It is important to note that, in spite of the previously mentioned organizational and hierarchical shortcomings of the EAC, the process and structure used by BNI to develop the EAC is capable of providing a reasonable result.

Table 3-1 summarizes to-go costs represented in the May 2006 EAC by facility. This table, while not presented in the May 2006 EAC submittal, was provided by BNI at the request of the IVR Cost Team to consolidate the pertinent features of the EAC. The pertinent features are the total unescalated ETC direct costs (see the Grand Total line item) and line items for adders. The adders are escalation, late adjustments, contingency, and actual cost-to-date (ACTD). The sum total of direct ETC cost and adders is the total forecast at completion. Additional estimated cost to the WTP for Fee and Technical and Programmatic Risk Assessment (TPRA) is noted in the footnote to the table.

Table 3-1. BNI Summary of May 2006 EAC To-Go Costs by Facility

All figures are UNEscalated ($ thousands)							
Estimate Category		**PT**	**LAW**	**HLW**	**BOF**	**LAB**	**Grand Total**
Design & Permitting	Engineering	112,675	19,772	53,870	9,908	7,257	203,482
	PWEPCC Allocation	110,683	40,367	71,495	22,377	15,006	259,928
	E & NS	9,021	4,810	7,620	3,265	3,828	28,545
	Allocation	31,900	13,013	21,448	10,654	7,325	84,339
	Research & Technology	38,375	8,096	15,946	-	-	62,417
	PWEPCC Allocation	16,590	7,005	11,256	3,070	2,151	40,072
Design & Permitting Total		**319,245**	**93,063**	**181,635**	**49,275**	**35,566**	**678,783**
Procurement	Equipment	256,742	96,501	184,690	33,013	23,691	594,636
	Allocation	76,116	23,695	48,079	14,681	9,855	172,425
	Materials	77,639	8,506	35,329	5,824	6,212	133,509
	Allocation	16,331	2,010	10,685	2,611	928	32,565
	Acquisition Services						-
	PWEPCC Allocation	35,787	8,704	24,115	7,213	3,379	79,198
Procurement Total		**462,616**	**139,416**	**302,897**	**63,341**	**44,064**	**1,012,334**
Construction Total	Construction	453,912	116,895	300,162	80,352	45,417	996,738
	PWEPCC Allocation	107,048	54,192	79,041	54,749	36,643	331,673
Construction Total		**560,960**	**171,087**	**379,203**	**135,100**	**82,060**	**1,328,410**
Startup &	Startup & Commissioning	96,219	79,930	68,538	118,900	80,251	443,839
	PWEPCC Allocation	404,692	101,079	284,512	86,659	36,683	913,624
Startup & Commissioning Total		**500,911**	**181,009**	**353,050**	**205,559**	**116,933**	**1,357,463**
Shared Services Allocation		**265,643**	**91,789**	**172,219**	**67,560**	**46,823**	**644,034**
Grand Total		**2,109,374**	**676,365**	**1,389,004**	**520,835**	**325,446**	**5,021,024**
Escalation		**263,764**	**94,887**	**184,000**	**82,359**	**60,152**	**685,163**
Late Adjustments		**114,804**	**63,625**	**87,910**	**41,649**	**29,435**	**337,423**
Project Contringency	**EPCC Risk**	362,491	108,500	216,840	103,874	74,975	866,680
	Contractor Technical Risk	135,451	53,325	65,803	57,819	4,728	317,126
	Schedule Risk	68,600	27,000	44,000	17,000	10,200	166,800
	DOE Contingency	99,830	51,212	69,159	52,251	27,547	300,000
Project Contringency Total		**666,372**	**240,037**	**395,802**	**230,944**	**117,450**	**1,650,606**
To Go Costs FY06 - FY18		**3.154.315**	**1.074.915**	**2.056.716**	**875.788**	**532.482**	**7.694.216**
To Date Costs thru FY05		**1,088,904**	**560,233**	**669,737**	**315,221**	**108,735**	**2,742,831**
Total Forecast at Completion		**4,243,218**	**1,635,148**	**2,726,453**	**1,191,009**	**641,218**	**10,437,046**

Excluded are allowances for fee, credits ($84M -Spare Melters, etc) and Technical and Programmatic Risk Assessment (TPRA - $1,116M).

Note: Plant Wide Engineering Procurement Construction and Commissioning are cost estimates for activities not directly associated with a particular facility. The estimates are allocated to specific facilities on a cost percentage or direct hire craft hour basis.

The focus of the cost validation effort and the above table was the ETC cost based on ETC quantities, pricing, and installation unit rates as of second quarter fiscal year (FY) 2006. The adders, except for the ACTD, were evaluated differently than ETC cost but are based on ETC. Evaluation of the ACTD was performed to ensure that actual cost was collected properly and was current to the data date of the EAC.

3.4 Validation Results

Based on the selection methodology employed by the IVR Cost Team, 21 different cost elements were selected for detailed review from the five cost areas. The following tables summarize the evaluated EAC costs for those elements and their respective validation results (referenced findings and observations are provided in sections 3.7 and 3.8, respectively):

Table 3-2. Evaluated Costs and Validation Results - Cost Areas

Cost Areas	Total EAC $K*	% Analyzed**	Validated	Finding No.	Observation No.
Design & Permitting	**$1,766,479**	**72.2**	**Yes**	**2**	**1**
Engineering	$1,229,376	60.1			
Environmental & Nuclear Safety	$202,165	100.0			
Research & Technology	$334,941	100.0			
Procurement	**$1,657,452**	**40.0**	**Yes**	**2**	**1**
AS	$281,861	0.0			
Plant Equipment & Material	$1,375,591	45.7			
Construction (Includes Direct Capital Costs)	**$2,933,541**	**79.4**	**Yes w/adjustment**	**1, 2**	**1, 3**
Direct Capital Costs (Approx. due to Cobra adders)	$2,208,380	72.6			
Field Non-manual	$725,161	100.0	Yes w/adjustment	1, 2	1, 3
Shared Services	**$1,088,225**	**75.5**	**Yes**	**2**	**1, 2**
SCT	**$1,003,320**	**100.0**	**Yes**	**2, 3**	**1, 2**
Late Adjustments	**$337,420**	**100.0**	**Yes**	**NA**	**NA**
Total EAC Cost Estimate	***$8,786,437***	***73.2***	**Yes w/adjustment**	**1, 2, 3**	**1, 2, 3**

* Costs are escalated and based upon May 2006 EAC.

**Based on EAC value.

Table 3-3. Evaluated Costs and Validation Results - Direct Capital Cost Elements

Direct Capital Costs (Commodities)	Total BETK $K*	% Analyzed**	Validated	Finding No.	Observation No.
Site Work	$36,600	97.7	Yes	2	1, 3
Concrete Related	$326,076	83.1	Yes	2	1, 3
Structural Steel	$180,532	98.2	Yes	2	1, 3
Architectural	$76,451	46.4	Yes	2	1, 3
Piping Bulk Commodities	$335,017	100.0	Yes w/adjustment	1, 2	1, 3
Electrical Bulk Commodities	$106,988	65.7	Yes w/adjustment	1, 2	1, 3
Instrumentation	$132,053	64.5	Yes w/adjustment	1, 2	1, 3
Insulation, Fireproofing	$83,712	75.0	Yes	2	1, 3
Packaged Units, Physical Processing and HVAC	$166,774	99.6	Yes	2	1, 3
Electrical	$55,957	41.2	Yes	2	1, 3
Columns and Vessels (Mechanical Systems)	$149,996	77.7	Yes	2	1, 3
Jumpers (Melter Systems Design)	$78,793	77.5	Yes	2	1, 3
Melter Equipment (Melter Systems)	$89,623	100.0	Yes	2	1, 3
Process Mechanical Equipment (Mech Systems)	$156,442	65.4	Yes	2	1, 3
Mechanical Handling Equipment	$143,266	66.4	Yes	2	1, 3
Total Amount Analyzed	**$2,118,280**	**81.5**	**Yes w/adjustment**	**1, 2**	**1, 3**
Total BETK Costs (May 2006)	**$2,379,105**	**72.6**	**Yes w/adjustment**	**1, 2**	**1, 3**

Although certain capital element and commodity item evaluations occurred on selected facilities, the review and validation of those items represents all facilities. The methods used by BNI for estimating quantities, pricing, and unit rates for a given commodity were similar for all facilities. Evaluation of the other four key cost areas encompassed all facilities. Therefore, the IVR Cost Team approached its validation and this report from a total WTP EAC perspective.

As noted earlier, the IVR Cost Team validates the May 2006 EAC cost estimate conditional upon including a direct cost adjustment for insufficient craft unit rates applied to electrical, piping, and instrumentation commodities. A net cost adjustment of $320 million to the base estimate is recommended and is comprised of the following components:

- $157 million net increase for additional craft labor hours.
- $41 million net increase for associated distributable craft labor.

- $122 million net increase for associated field non-manual labor.

Appendix E, table E-47, provides development methodology and basis detail for this adjustment.

The IVR Cost Team coordinated closely with the IVR Risk Team evaluating WTP EAC risk weightings. For example, because of an IVR Cost Team adjustment to the EAC accounting for unit installation rate concerns, the IVR Risk Team assigned a higher confidence level to the corresponding risk area. Conversely, based on the cost review, risk confidence levels in Shared Services were reduced from high to medium, resulting in a contingency increase from 5 up to 10 percent for Shared Services.

The IVR Cost Team observed and noted several aspects of BNI's cost estimating, planning, and performance monitoring process that were viewed as significant contributors to enhancing both the quality and accuracy of the May 2006 EAC. Many of these enhancement items should also strengthen BNI's ability to effectively manage cost growth in the future. Specific examples of such observations are identified as follows:

- The reorganization of engineering to a central Engineering Group is a positive step that increases the ability of BNI to meet performance and budget commitments. Uncertainties, initially noted by the IVR Team in post-production engineering job hour to-go estimates, were addressed and covered adequately in the May 2006 EAC.

- The modeling methodology employed by BNI AS Group to develop the staffing plan supporting the May 2006 EAC was well developed and executed. The structure allows procurement management the ability to approach "what if" schedule scenarios systematically and assemble credible procurement staffing plans to support those scenarios.

- The E&NS estimate in the Plant Wide Engineering, Procurement, Construction, and Commissioning (EPCC) was well structured; estimate detail included appropriate basis statements and assumptions. Further, E&NS presented relevant benchmarking data to support the estimate.

- Quantity development methodologies for many bulk commodities were well described, defendable, and reflected reasonable consideration and adjustment for facility design uncertainties, evolving technical issues, and design completion status. The quantity development methodologies were applied consistently and accurately throughout reviewed facilities.

- Material unit pricing and material total costs presented by BNI for the selected sub-commodities were based on reasonable and defendable methodologies accurately and consistently applied to the estimated quantities. Adjustments to piping fabrication unit costs, as suggested by the IVR Cost Team, based on

ACTD were acknowledged by BNI as appropriate and were reflected in the May 2006 EAC.

3.5 Cost Evaluation Criteria Matrix Analysis

The determination of validation for evaluated cost elements required a degree of judgment and subjectivity. To add defensibility to the cost validation effort, the IVR Cost Team employed a Criteria Matrix Analysis of the December 2005 EAC to supplement and further quantify the Pareto evaluation effort (appendix E provides details of the matrix analysis). The criteria matrix approach reduced the subjectivity component inherent to the validation process. The IVR Cost Team established and weighted eight cost criteria. Knowledge gained from reviewing and evaluating Direct Capital Cost, Design and Engineering, Procurement and Construction, and Shared Services information carried forward in evaluating the WTP EAC against each criteria in the matrix. Subsequent review and variance analysis performed against the May 2006 EAC did not result in adjustments to this matrix analysis. The Cost Criteria Matrix Analysis did not include SCT.

3.5.1 Cost Evaluation Criteria Matrix Analysis Approach

The IVR Cost Team evaluated the EAC against the following eight criteria:

A - EAC Quantities
B - EAC Traceability
C - EAC Subcontract Forecasts
D - EAC Staffing Levels
E - EAC Unit Rates
F - EAC Escalation
G - EAC Scope of Work
H - EAC Pricing

The following are the four steps in the criteria analysis:

1. Determine evaluation criteria.
2. Weight the evaluation criteria.
3. Evaluate the EAC against each criteria.
4. Determine the validity of the specific element of the EAC.

Each team member assigned relative weighting factors ranging from 1 to 5 to each criteria. Each criteria item was then given a performance rating from 1 to 5 (poor to excellent). The IVR Cost Team individually rated each criteria and then reached group consensus as to the level of performance for each item as related to generally accepted cost estimate techniques applied to the current WTP EAC. The combined inputs from all team members resulted in a calculated mean analysis value for each criteria of 1 (Poor), 2 (Fair), 3 (Good), 4 (Very Good), or 5 (Excellent).

3.5.2 Cost Evaluation Criteria Matrix Analysis Results

A brief summary of the performance ratings and justifications for each evaluation criteria is provided as follows:

EAC Quantities – This criteria received the highest score among all criteria. It was rated "very good." Quantities were presented in consideration of actual and estimated values where appropriate, estimated quantities were developed utilizing standard methodology, subject matter expertise of BNI was adequately involved, and quantities were reasonable and comprehensively represented throughout EAC documentation.

EAC Traceability – This criteria received the lowest score among all criteria. Traceability was rated as "fair," due to the Team's inability to readily trace data from one source to another and from individual details to summary data represented consistently in BETK, quantity development packages, and the EAC. Evaluation typically required significant effort and considerable involvement from numerous Team members. BNI personnel were routinely requested to provide direct explanation in meetings and phone conversations due to perceived discrepancies between volumes and difficulty understanding the logic used. Further, there appeared to be numerous manual entries made during the process of estimate development (e.g., Cobra load transfers) that required further explanation.

EAC Subcontract Forecasts - Rated as "very good," subcontracting is well managed by BNI and forecasts are developed with ample detail and consideration. BNI develops estimates as if they are to perform the work with direct hire personnel and then allows for variations in cost when issuing a subcontract. In other situations, BNI negotiates costs with the subcontractor until satisfactory resolution is achieved for both parties based on the initial estimate developed by BNI. Overall, the subcontracts are actively managed and costs seem reasonable and comprehensive.

EAC Staffing Levels – Rated as "very good," there was general agreement that Engineering, Procurement, and Environmental and Nuclear Safety (E&NS) staffing levels are well developed and presented. There was some concern about field non-manual staffing, resulting in an overall reduction in confidence for this criteria. When benchmarks for field non-manual staffing were compared to detailed staffing levels developed by BNI and deviations identified, it appears as if BNI adjusted staffing levels (up) and resulted in what would be normally be considered "factored" estimates.

EAC Unit Rates – Rated at slightly less than "good," the Team expressed some doubts as to whether or not historical unit rates are being correctly applied to the forecasted future rates. This issue ultimately resulted in a recommended cost adjustment. It was noted, however, that there are cases where BNI is meeting or exceeding expected productivity. An independent review of selected piping, electrical, and mechanical handling unit rates resulted in aggregate installation labor costs that compared favorably with those in the EAC.

EAC Escalation – All Team members agreed that an appropriate use of escalation is already covered in the estimate and has been adequately addressed by the IVR Team during the course of the review.

EAC Scope of Work – Rated as "good," the scope of work is adequately defined and represented throughout the EAC documentation in that all work is included and estimated. Recognizing that numerous changes have been implemented since initial contract award, sufficient design detail has been developed for those changes to justify the rating.

EAC Pricing – Rated as "very good," pricing has been sufficiently justified and is based on historical facts or other legitimate standards. BNI used negotiations with vendors and subcontractors, existing labor agreements, and material requisitions and awards to develop pricing. Further, it was noted that BNI personnel obtained unit pricing on commodities and materials before unit quantities were complete and utilized relevant pricing information to develop the EAC. BNI did not consistently make adjustments when they had actual purchase data that indicated an adjustment might be appropriate.

The above criteria ratings, together with weighting factors, which assign a Team-consensus relative importance to each evaluation criteria, were then analyzed using value engineering methods typically employed by USACE. The resulting matrix analysis resulted in a score exceeding that required for validation. Subsequent review and variance analysis performed against the May 2006 EAC did not result in adjustments to this matrix analysis. Appendix E provides details of the matrix analysis approach and results.

3.6 Startup, Commissioning, and Training Results and Discussion

The IVR Cost Team used their experience in design, construction, startup, commissioning, and training at commercial nuclear and fossil fuel powerplants and DOE nuclear waste complex facilities to review and evaluate the plans, estimates, and schedules developed by BNI to perform the SCT necessary to safely operate the WTP.

3.6.1 Cost Estimate Summary

The December 2005 EAC cost estimate for SCT was $830 million. During this review process, the IVR Cost Team recommended that BNI increase SCT budget in the May 2006 EAC to provide for uncertainties related to hiring and retaining qualified personnel. Subsequently, the ERT recommended that Operations increase personnel levels to provide a fully trained operating and maintenance staff through both cold and hot commissioning. BNI then included, as a late adjustment, an additional $130 million, or about 15 percent, to the May 2006 EAC.

Final plant certification requires demonstration of sustained operations with specific process feed throughput and final waste canister production criteria. These provisions require long-term planning for staffing, equipment maintenance, and procedure development. This is not typical for a commercial construction approach, which introduces significant challenges relative to total project cost as well as SCT schedule projections. Due to these uncertainties, BNI has included significant additional schedule durations for known SCT steps and has applied a significant schedule duration

contingency to the WTP project schedule. The schedule duration contingency has a cost component that is included in the SCT project contingency.

3.6.2 Identified and Evaluated Risks

The IVR Cost Team investigated assumptions, technical uncertainties, and schedule variables associated with the EAC SCT estimate. During this process, identification and evaluation of the most significant risks became necessary. The Team prepared detailed discussion, significant observations, and key mitigating recommendations associated with these risks (presented in appendix E and other supporting documentation). Summary discussions of the more significant risks are presented as follows:

- **Personnel Hiring and Training** – Existing nuclear powerplants, planned nuclear powerplants, and several Government nuclear facilities that are under construction (such as the Mixed Oxide Fuel Fabrication Facility, Yucca Mountain, and Global Nuclear Energy Partnership projects) will be competing for a limited pool of experienced personnel.

- **Jurisdictional Labor Issues** - In the EAC, the BNI plan for SCT is that non-technical employees, such as operators, radiation technicians, and maintenance workers be non-union, multi-skilled, and capable of performing more than one task. Due to a historical precedent on the Hanford site and a reasonably strong union presence in Eastern Washington, BNI may be required to utilize Hanford Atomic Metal Trades Council (HAMTC) union labor rather than the multi-skilled non-jurisdictional workers as envisioned. This risk represents potential cost and schedule impacts as a result of the inherent jurisdictional work rule limitations or other work-related issues of a HAMTC union labor workforce. This risk issue was identified to the IVR Risk Team. It is discussed in detail of section 5.0 of this report.

- **Remote Handling and Pretreatment Process Difficulties** – The PT facility is essentially a pioneer project that will process a mixed waste stream that is both chemically complex and highly radioactive. During operations, the combination of treating a large volume of radioactive chemical waste with many constituents and the requirements to perform all work remotely is problematic. Remote operations and maintenance work has not been demonstrated on the equipment and processes that will be used at WTP. While the WTP commissioning schedule currently accounts for some redesign and construction errors, there is a notable risk that these items may well be larger than anticipated and may have a significant impact on the project.

- **Operational Readiness Review** – The DOE-HQ Operational Readiness Review (ORR) duration is planned to last 4 months. This relatively short amount of time to perform a DOE-HQ ORR for the WTP appears unrealistic and is not consistent with historical experience. Historically, ORRs for smaller

projects have taken considerably longer. Unexpected problems and unresolved items typically delay such efforts.

- **Operations Turnover** - The transition to the operating contractor may introduce different management, supervision, procedures, training and certification requirements, programs, and contracts. This could reduce productivity, cause confusion, or otherwise slow the transition process, thereby, extending the scheduled duration of the transition.

3.6.3 Conclusion

As a result of this evaluation, the IVR Cost Team identified two key areas of risk, relative to the WTP SCT scope and cost estimate: (1) out-year SCT staffing needs, and (2) potential for a labor union ruling that would change the SCT workforce from non-jurisdictional, multi-skilled workers to HAMTC union workers.

To provide for uncertainties related to hiring and retaining qualified personnel, BNI included, as a late adjustment, an additional $130 million, or about 15 percent of the SCT estimate, to the May 2006 EAC. Additionally, the IVR Cost Team recommends a $250 million adjustment to TPRA contingency to address the potential out-year introduction of union labor rather than the multi-skilled non-jurisdictional workers. This issue is addressed in detail in section 5.0.

The IVR Cost Team validates the May 2006 EAC for the SCT work scope with the recommended TPRA contingency adjustment included.

3.7 Findings

Finding 1: The IVR Cost Team concludes that BNI craft labor estimates are adequate in all areas except electrical, piping, and instrumentation commodities. For these commodities, the Team evaluated and compared the unit installation rate performance to date with BNI unit rates in the May 2006 EAC. Based on this comparison and independently derived unit rates for electrical bulk commodities, the IVR Cost Team concludes that these estimated unit installation rates are inadequate.

> **Recommendation**: The IVR Cost Team recommends a net positive adjustment of $157 million to the May 2006 EAC for additional craft hours and a corresponding increase of $163 million for distributable craft labor and field non-manual labor. Appendix E, table E-47, provides detail and identifies the suggested distribution for this adjustment.

Finding 2: The lack of data traceability within the EAC demonstrates a weakness in methods used to generate and organize the estimate basis and development data. It appears that multiple data development systems tabulate the same data and that these systems operate independently of each other relying on significant non-integrated transfer of data, providing opportunities for discrepancies within a submittal.

This weakness complicates the use of this EAC as the basis for a future performance measurement baseline (PMB).

> **Recommendation**: The IVR Cost Team recommends that BNI establish an electronic interface between the multiple data development and control systems, eliminating the requirement for extensive manual loading of data, to increase the operating ease and competence of the system as a whole. Effective integration of data systems provides a more timely response to project cost and schedule impacts.

3.8 Observations

Observation 1: There are numerous inconsistencies of data between details and summaries in the EAC that suggest a less than comprehensive review of the data prior to issue of the EAC. A review of the Shared Services staff estimate indicates that line items for staffing and ODC appear to be reasonable, but the BNI Project Controls section lacks an item for an independent QA staff to oversee EAC preparation.

> **Recommendation**: BNI should establish an independent quality review team to perform detailed quality reviews of all WTP Project Control products.

Observation 2: The IVR Cost Team identified several areas of potential risk for the SCT effort including staffing acquisition, evolving technical issues, remote equipment performance, ORR duration, and the operational contractor transition plan.

> **Recommendation 1**: The IVR Cost Team recommends that BNI and DOE-ORP take a proactive position regarding these risks to ensure the highest probability of SCT success with minimal cost and schedule growth. Specific recommendations that target the monitoring, reduction, and mitigation of these risks are included in appendix E.

> **Recommendation 2**: The IVR Cost Team recommends that BNI and DOE-ORP extend the DOE-HQ ORR schedule to accommodate a full review of procedures, documentation, qualifications, and capabilities of the WTP. A likely scenario for the HQ-ORR is that, due to the complexity, uniqueness, and size of the WTP, four ORR efforts will be required, one each for BOF/LAB facilities, PT facility, HLW facility, and LAW facility. If BNI is fully prepared, all issues are resolved, and all documentation is in order, each ORR should take 3 weeks, followed by 2 weeks to answer questions, resolve items, and resolve interface issues. Several weeks will be consumed between facility ORRs for closeout and restart of the next ORR. The 4-month schedule currently reflected in the May 2006 EAC may be optimistic, and it is recommended that BNI further examine the schedule in collaboration with DOE-ORP.

Observation 3: The ratio of field non-manual job hours to craft job hours for ETC is 41 percent. A 5-year history of performance indicates an actual ratio of 51.5 percent.

Although a 41 percent ratio may be achievable within nuclear industry standards, it appears optimistic based on recorded performance for the project.

> **Recommendation**: The IVR Cost Team recommends BNI monitor and manage the field non-manual to craft job hour ratio to achieve more reasonable ratios commensurate with normal industry standards.

3.9 General Comments on May 2006 Estimate at Completion Changes

The IVR Cost Team evaluated the details of the December 2005 EAC in depth during a 5-month period from January 2006 through May 2006. The EAC presented a total cost estimate of $7.736 billion excluding contingency. The result of the evaluation indicated that, with preliminary adjustments identified, the December 2005 EAC was representative of the cost of the WTP project scope at that time.

Subsequently, BNI produced the May 2006 EAC, based on a February 24, 2006, data date (issued May 26, 2006). The total estimated cost of the May 2006 EAC is $8.786 billion excluding contingency, for a $1.050 billion increase to project cost since the December 2005 EAC. The IVR Cost Team reviewed the May 2006 EAC and concluded that the estimate for the project scope represented in the May 2006 EAC is accurate, appropriate, and conditionally validated with the $320 million construction labor adjustment plus contingency additions.

The May 2006 EAC was officially issued on May 26, 2006. The IVR Cost Team subsequently spent about 2 weeks evaluating and analyzing all additions, deletions, and modifications relative to the December 2005 EAC as input for validation before finalizing this report. Normally, such a short duration would preclude a competent review of such a large submittal. In anticipation of this short evaluation timeframe, the IVR Cost Team integrated team members with the BNI EAC development team during May 2006 to obtain advance information and to formulate an approach to quickly evaluate the final EAC. The following significant changes were presented in the May 2006 EAC:

- Technical and cost recommendations from the EFRT and the ERT evaluation teams (see section 2.2.2).
- Late adjustments from the December 2005 EAC into the budget base.
- Refined Revised Ground Motion engineering approach.
- Revised pricing based on actual material and equipment unit costs.
- Construction disruption due to funding restrictions.

The IVR Cost Team developed a standard process for reviewing each of the items in the May 2006 EAC that were previously reviewed from the December 2005 EAC. The process included creating a table of estimated cost comparisons for each major cost

component between the December 2005 EAC and the May 2006 EAC. The IVR Cost Team made note of any significant changes and performed a detailed review of the May 2006 EAC documentation to ascertain the main causes for the component's change. The result of this review established that, while the May 2006 EAC has shown a cost increase, the major changes are justifiable within the acceptable variances described above and comprise a valid representation of cost for the May 2006 EAC work scope.

BNI's May 2006 EAC reconciled all cost changes (increases and decreases) according to six categories as follows:

- Time Dependent/Funding – Cost impacts due to schedule extensions consisting of escalation, facility extensions, and cost of the project office.
- Project Events – Costs due to a maturing of the plant design since the DOE-ORP established baseline.
- Design Evolution - Costs due to a maturing of the plant design since the DOE-ORP established baseline.
- Project Efficiency and Disruption – Costs due to changes in unit rates and performance factors that are greater or less than estimated in the December 2005 EAC.
- Pricing – Costs due to changes in pricing of labor, materials, and equipment since the previously recognized contract baseline was established.
- Other Changes – Changes to costs may be a result of a transfer of costs between facilities or may be due to minor changes that are not otherwise categorized.

Table 3-4 summarizes the direct cost change reconciliation in the May 2006 EAC for each of the six cost change categories identified by BNI is as follows:

Table 3-4. Summary of Direct Cost Changes - December 2005 EAC vs. May 2006 EAC

Category	Cost	EAC Change
Time Dependent/Funding	$444 M	48.8%
Project Events	$252 M	27.7%
Design Evolution	$28 M	3.1%
Project Efficiency and Disruption	$53 M	5.8%
Pricing	$139 M	15.3%
Other Changes	$-6 M	-0.7%
Total[1] (rounding up)	$910 M	100%

[1] Excludes net difference of $140 million between May 2006 and December 2005 late adjustments.

SECTION 4.0 - SCHEDULE REVIEW

4.1 Introduction

The schedule for the May 2006 EAC is developed, maintained, and then presented for the purpose of project management using the Primavera Project Planner® (P3) scheduling software. As employed for the WTP project, the schedule is typically presented at one of four levels. BNI maintains a detailed Level 4 (working level) schedule that includes over 47,000 discrete activities including nearly 28,000 to-go activities. The Level 3 schedule (a summary version, or rollup, of the working schedule) is used for reporting purposes and includes approximately 3,500 activities. The May 2006 EAC Level 3 schedule was being developed by BNI and was not available for this validation review. The Team did analyze the December 2005 EAC Level 3 schedule. Site senior management and DOE-ORP personnel use the Level 3 schedule for most project oversight activities. The schedule may also be rolled up for presentation at Level 2 (approximately 240 activities) or at Level 1 (approximately 80 activities).

4.2 Methodology

The IVR Schedule Team conducted an extensive review of the current WTP schedule that provided a basis for development of the May 2006 EAC, and assessed its accuracy and viability. The Team concentrated on the Level 4 schedules for the three primary facilities: PT facility, LAW facility, and HLW facility.

The remaining two facilities, BOF and LAB do not appear to impact the remaining project schedule; therefore, no effort was expended reviewing the schedule for those facilities.

4.3 Schedule Accuracy

The IVR Schedule Team assessed schedule accuracy through analysis of activity durations, constraints, critical path analysis, and comparison of the system-wide schedule baseline structure to the scheduling structure guidelines included in the P3 scheduling tool and to BNI procedures. Specific target areas for the IVR Schedule Team's evaluation of schedule accuracy are defined and discussed as follows:

- An activity duration is the planned period of time assigned to the scope of work to be executed for engineering, procurement, construction, and startup. Level 4 activity durations should be short enough so they can be accurately monitored and statused to demonstrate any impact on successor activities. A Level 4 schedule presentation should be in sufficient activity detail to provide a greater level of detail in the first 18 to 24 months and less detail beyond 24 months. Incorporation of this "rolling wave" concept provides an optimum level of detail for managing the project.

- A constraint is a restriction imposed on a project or activity. When used on schedule activities, a constraint can be assigned to indicate a desired start or complete date. An analysis of schedule constraints was performed on the WTP Level 4 schedule to determine if constraints were impacting any critical or near critical paths and assessed any impacts to paths affected by the constraints.

- The critical path is the collection of schedule activities that dictate project completion milestones and that impact project completion if changed without mitigating action or revisions to logic. The critical path identifies the longest path through the schedule determined by the calculations preformed by the scheduling software. The IVR Schedule Team performed an analysis of the critical path in the WTP Level 4 schedule. It included analysis of specific project or facility level schedules. Each of the HLW, LAW, and PT facilities has a unique critical path to completion. Currently, HLW facility building durations appear to be longer than durations for the PT facility, therefore the critical path should contain mostly activities related to the HLW facility. A summary schedule showing the critical paths through each facility and the HLW contribution to the overall WTP critical path is shown in figure 4-1. A summary level WTP critical path is shown in figure 4-2.

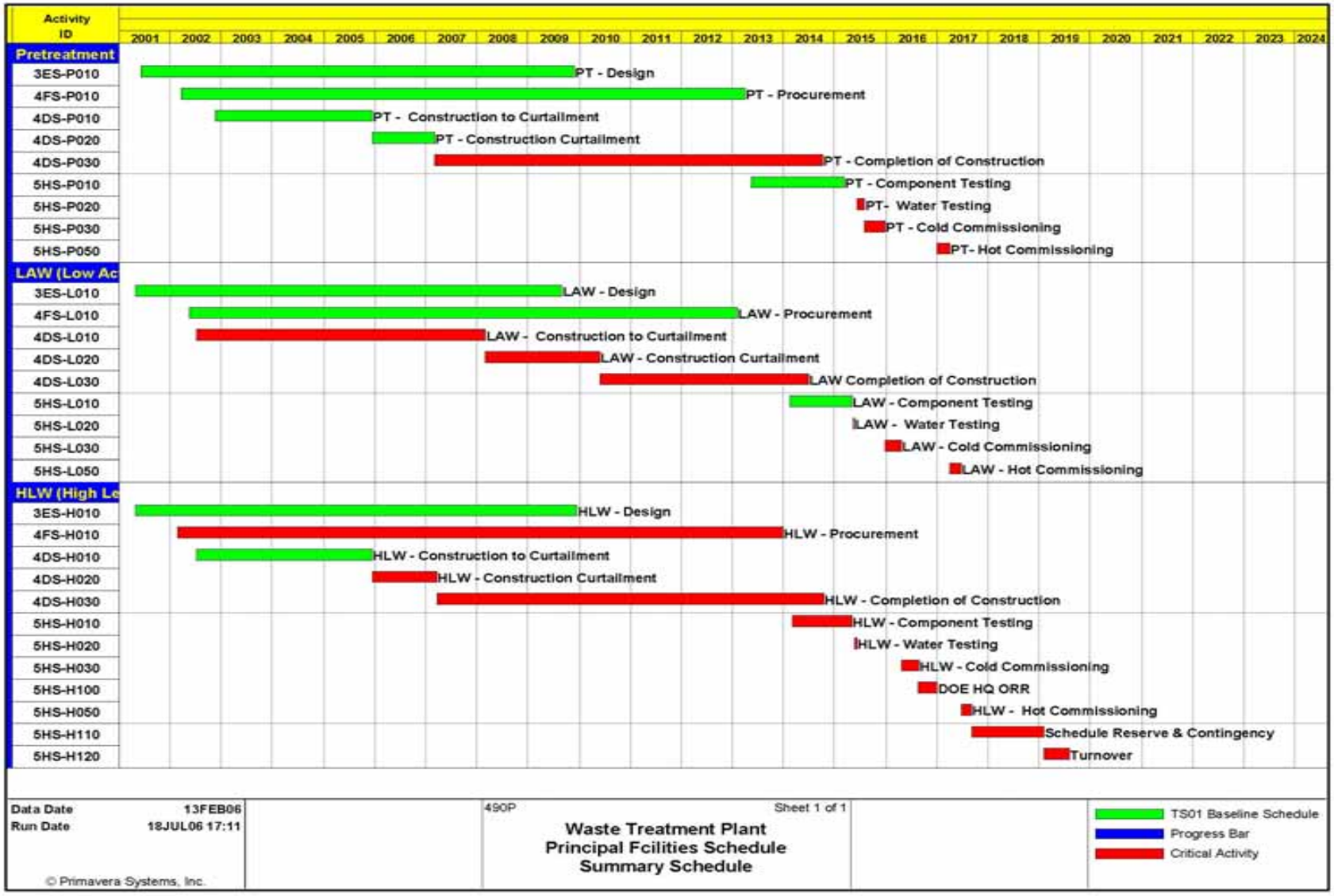


Figure 4-1. Summary Facility Critical Paths

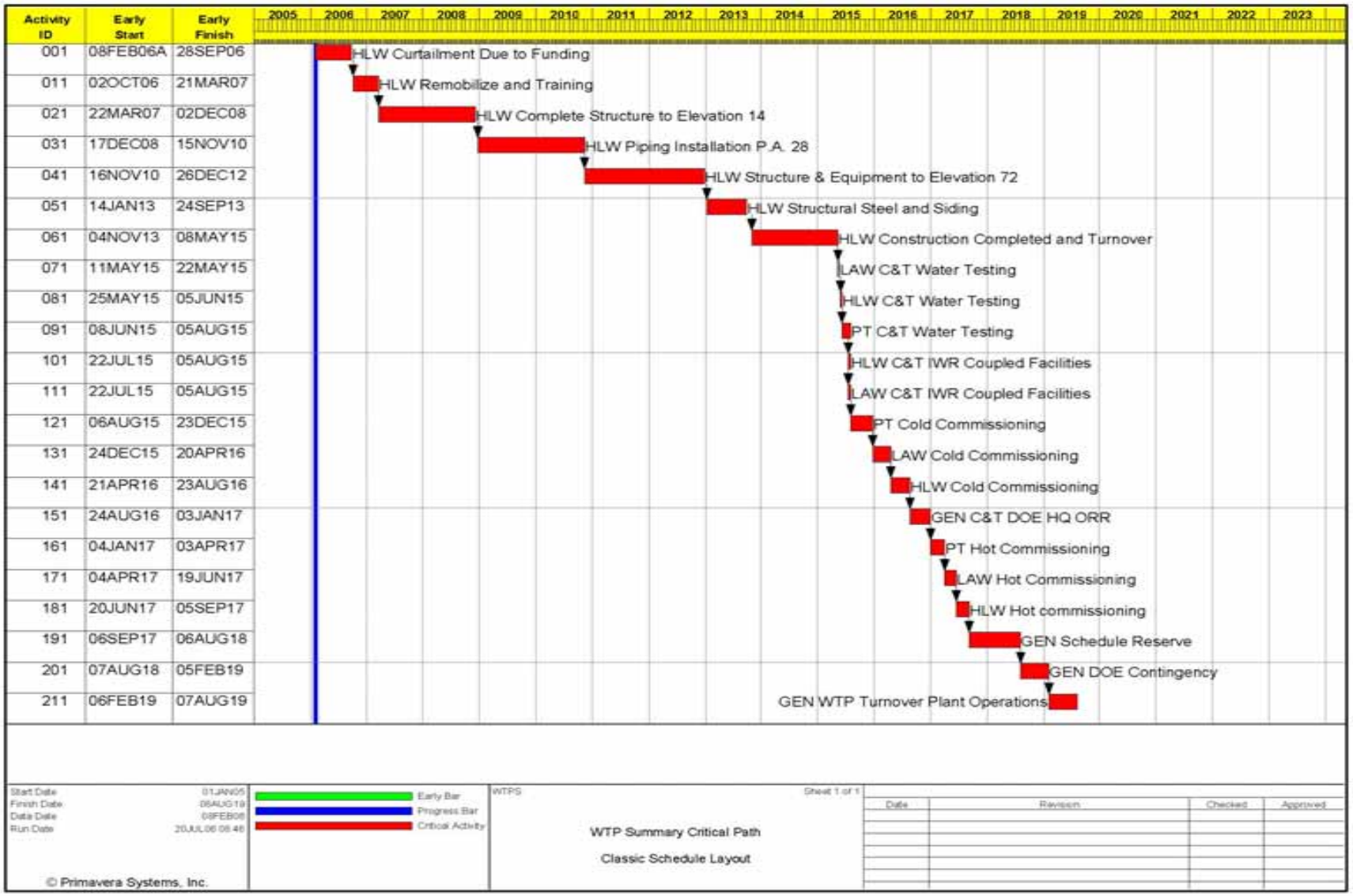


Figure 4-2. Summary WTP Critical Path

Preliminary analysis focused on the HLW and PT facilities to determine if critical paths were logically driven from activities currently underway to the completion of hot commissioning.

- The IVR Schedule Team compared the system-wide schedule structure to the BNI scheduling guidelines provided in volume 1 of the May 2006 EAC. The Team focused on structures that were deemed important to success of the schedule. Therefore, the IVR Schedule Team reviewed activity codes that were critical to sorting and grouping of schedule elements for analysis. WBS codes and schedule hierarchy were among the elements reviewed.

- The Level 3 reporting schedule is a system-wide method for reporting developed through an activity rollup of related Level 4 tasks within the schedule. Although the final Level 3 schedule had not been completed at the time of the validation review, the IVR Schedule Team analyzed the existing Level 3 schedule to determine if the code field structure had been accurately applied. The Team also analyzed Level 3 summary activities to determine if those activities represent meaningful scopes of work. For example, a single activity representing design for a facility would not provide adequate detail for reporting. At the other extreme, design for a particular piece of equipment is not necessary for those same reporting purposes. The IVR Schedule Team reviewed the BNI process for developing and maintaining the Level 3 schedule including Change Control, Progress/Updates, etc.

4.4 Schedule Viability

When a schedule is developed by establishing predecessor and successor relationships between Level 4 activities, the longest series of activities establishes the length of the project or the critical path. Schedule activities that are not included in the critical path can begin when their predecessor activity(s) are complete (an activity's early start), but do not have to be completed until their successor activity(s) must start to avoid delaying the project (an activity's late finish). The difference between an activity's early finish date and its late finish date is the total float for that activity. Any activities with excessive total float can render a schedule ineffective for use as a management tool. The IVR Schedule Team assessed schedule viability through analysis of critical paths and review of activities with excessive float values.

The IVR Schedule Team analyzed critical and near critical paths for each primary facility. The relationships and durations of activities on these paths were reviewed to determine if the schedule was reasonable, included all appropriate activities and relationships, and completion of hot commissioning at each facility could be achieved in a logical and timely manner.

4.5 Schedule Evaluation Criteria Matrix Analysis

Verification of schedule accuracy and viability requires a degree of judgment and subjectivity. To supplement and quantify the evaluation effort and validation conclusions, the IVR Schedule Team employed a criteria matrix analysis approach to analyze both the December 2005 EAC and May 2006 EAC schedules (appendix F provides details of the matrix analysis). This approach, previously discussed in section 3.5, uses value engineering principles to evaluate multiple criteria to arrive at a single overall decision regarding validation.

4.5.1 Schedule Evaluation Criteria Matrix Analysis Approach

The IVR Schedule Team evaluated the EAC against the following eleven criteria:

A - Schedule Maintenance/Management
B - Critical Path
C - Relationships/Logic
D - Constraint Analysis
E - Resource Loading
F - Schedule Contingency
G - Schedule Structure
H - Schedule Summaries/Hierarchy
I - Float Analysis
J - Activity Durations
K - Schedule Usability

The following are the four steps in the criteria analysis:

1. Determine evaluation criteria.
2. Weight the evaluation criteria.
3. Evaluate the EAC against each criteria.
4. Determine the validity of the specific element of the EAC.

Each team member assigned relative weighting factors ranging from 1 to 5 to each criteria. Each criteria item was then given a performance rating from 1 to 5 (poor to excellent). The IVR Cost Team individually rated each criteria and then reached group consensus as to the level of performance for each item as related to generally accepted cost estimate techniques applied to the current WTP EAC. The combined inputs from all team members resulted in a calculated mean analysis value for each criteria of 1 (Poor), 2 (Fair), 3 (Good), 4 (Very Good), or 5 (Excellent).

4.5.2 Schedule Evaluation Criteria Matrix Analysis Results

A brief summary of the performance ratings for the May 2006 EAC is provided as follows:

Schedule Maintenance/Management – A rating of “good” was given to this area. The update cycle, update methods, and enforcement of schedule structure are appropriate for a project of this type and size.

Critical Path – The IVR Schedule Team rated this criteria as "very good." BNI has scrubbed the activities related to the critical path and have eliminated hammocks (a hammock is a type of activity used to summarize a string of activities to a higher level), summary activities, constraints, long durations and improper logic relationships. This effort has provided a realistic and valid critical path.

Relationships/Logic – The IVR Schedule Team rated this criteria as "fair." The logic for numerous activities is not precise, clear, or easy to follow, and it includes redundant logic and shortcuts used on predecessors/successors relationships. These non-critical logic paths need to be reviewed to confirm the accuracy of the basic schedule elements through the remaining years. In all instances reviewed, these conditions did not have a detrimental impact on the activity flow or critical path.

Constraint Analysis – The IVR Schedule Team rated this criteria as "fair." Many constraints are not documented properly within the log note feature of the scheduling software, P3. Some constrained activities have also used a similar shortcut on predecessors. Many of these constrained activities are for fabrication and delivery of facility components with predecessors of "WTP Project Start." These activities should be preceded by a procurement activity and/or a design activity.

Resource Loading – The IVR Schedule Team rated this criteria as "fair." The schedule does not contain all of the labor hours and direct costs for the entire WTP. There is no consensus as to the definition of a resource-loaded schedule between DOE-ORP and BNI. This issue is to be addressed in a contract revision that is in process at this time. The rolling wave concept used on this project would require specific resources to be loaded in detail only on the near-term activities and more summary costs loaded on out-year activities.

Schedule Contingency – A rating of "very good" was given to this criteria. It is based on reasonable assumptions; the IVR Risk Team verified that it was within an acceptable range.

Schedule Structure – A rating of "very good" was given to this criteria. BNI has established an adequate Activity Code Structure to sort, group, and filter the activities in meaningful areas. BNI has also reviewed and scrubbed the activity code dictionary so that it is easier to locate and select important codes. BNI is also using these codes in a consistent manner.

Schedule Summaries/Hierarchy – The IVR Schedule Team rated this criteria as "fair." BNI plans to correct the Level 3 schedule in the near future, but as of the May 2006 EAC, it was not completed. Also, the schedule submitted with the May 2006 EAC does not have an updated Level 1 schedule.

Float Analysis – The IVR Schedule Team rated this as "very good." BNI has revised/corrected excessive float values on a large portion of schedule activities.

Although float is affected by relationships/logic, corrections currently needed on the logic will not have a major impact on existing float values.

Activity Durations – A rating of "very good" was given to this criteria. BNI has reviewed and modified activities and logic to breakdown activities with excessive durations. BNI has limited durations to approximately 250 days (or one year), which will provide better visibility to tasks in progress and to completed work. This condition was not imposed on activities that were beyond the 24-month concept desired for the May 2006 EAC project schedule rolling wave.

Schedule Usability – A rating of "good" was given to this criteria. The schedule will now support the requirements for meeting the May 2006 EAC.

The criteria ratings discussed above, together with weighting factors, resulted in a score for each criteria. The resulting combined score exceeded the minimum required for validation. Appendix F provides details of the matrix analysis approach and results.

4.6 Schedule Validation Analysis

The schedule submitted with the December 2005 EAC did not meet the requirements for validation by the IVR Schedule Team. BNI committed to correct the deficiencies identified by the IVR Schedule Team and submitted an improved schedule with the May 2006 EAC. The following discussion provides an analysis of the May 2006 EAC and identifies the specific areas of improvement from the December 2005 EAC schedule:

- The IVR Schedule Team observed major improvements in the area of resource loading of activities into the schedule. The current May 2006 EAC schedule has to-go engineering and construction hours loaded as well as certain commodity quantities, but no cost information. The commodity quantities loaded produce the commodity curves used by BNI for monthly reporting. The majority of resource assignments to activities can be tracked back to the estimating software. This indicates that scheduled resources and cost tracking software match.

- BNI reviewed schedule logic and revised existing activity flow for facilities to provide a more realistic, controlled duration, and float value. Previous activity durations of 800 or more days have been reduced to approximately 250 days.

- The December 2005 EAC schedule contained activities with up to 11 years of float. Such high float values are the result of improper schedule logic and are not consistent with a meaningful schedule. Float values in the May 2006 EAC schedule have been reduced to a maximum of approximately 300 days.

- Many hanging start activities (activities with no predecessor activity that are constrained to start on a specific date) have been amended to have a predecessor activity assigned to complete logic flow. However, the IVR

Schedule Team is concerned that some of the predecessor relationships are not meaningful because they appear to be assigned to the initial "Project Start" activity in 2001. Included in these activities are procurement and construction tasks that will actually start in 2006 and 2007.

- The May 2006 EAC schedule critical path appears to be reasonable and all constrained dates were removed from the critical path. This is an improvement over the December 2005 EAC critical path schedule in which BNI assigned codes to activities that represented "significant paths." These "significant paths" may have had activities with several hundred days of float calculated by the scheduling software that essentially invalidated it as a critical path. BNI used the criteria of low float and high risk to select activities for "significant paths" regardless of how much positive float was shown in the scheduling software. All reference to "significant paths" has been eliminated in the May 2006 EAC schedule.

- Excessive durations, which were a problem with the December 2005 EAC schedule, have been eliminated. The reduction of excessive durations in the first 24 months of the schedule helps to establish a true "rolling wave" concept that enhances the schedule for use as a management tool.

- A hammock is a type of activity used to summarize a string of activities to a higher level. A hammock does not belong on a critical path. Hammocks, which were included in December 2005 EAC critical paths, have been eliminated from the May 2006 EAC critical path. In addition, all activities that were summary, or Level 3, have been removed from the Level 4 critical path. All references to "significant paths" have been eliminated and only critical paths remain. Elimination of "significant paths" removed an area of confusion that had previously been in the schedule.

- BNI is currently working on correcting the Level 3 schedule as it is presented for management reporting. This is not a requirement imposed for validation of the May 2006 EAC schedule, but it is required for a final PMB version of the WTP schedule.

- The IVR Schedule Team worked with BNI to identify and resolve most of the inconsistencies described above. Although some inconsistencies still need to be addressed in the May 2006 EAC schedule, it is a significant improvement over the December 2005 EAC schedule. The current schedule appears to be valid and adequately supports the May 2006 EAC and the associated projected completion date for the WTP project.

4.7 Observations

Observation 4: Although BNI resolved several schedule issues, a problem remains with the logic assigned to constrained activities. Activity relationships do not appear to

be in a logically sequenced workflow. As one example, fabrication and delivery activities scheduled for completion in 2007 are preceded by the project start activity already completed in 2001 but should be preceded by a procurement activity. While this problem did not impact critical paths, it represents incorrect application of basic scheduling procedures.

> **Recommendation:** BNI must revise the schedule logic to reflect realistic sequencing of activities.

Observation 5: The schedule does not contain resource-loaded information for all the activities. BNI has a suite of related software that contains resource data, which BNI seems to feel is adequate for resource tracking. The schedule and this software have interaction that provides a basis for spreading the resources, but the total cost is not visible within the schedule data. Consequently, the BNI schedule does not represent a stand-alone tool for presenting resource requirements. BNI and DOE-ORP fail to agree on the definition of and need for a fully resource-loaded schedule.

> **Recommendation**: BNI and DOE-ORP must agree on the definition and tools utilized to develop an acceptable resource-loaded schedule.

Observation 6: The P3 "log" feature does not document the reason for each constraint in the Level 4 schedule. This identification would help define logic flow and provide a better picture of what or why delays have been encountered. Most of the issues related to constraints have been corrected on critical paths for the PT facility, LAW facility, and the HLW facility. However, BNI still has not identified the reason for remaining constraints.

> **Recommendation**: BNI should identify the reason for each activity constraint within the P3 "log" feature.

Observation 7: The schedule contains redundant relationships between activities including a large number of start-to-start and finish-to-finish relationships. Although these relationships do not necessarily impact critical paths or the final completion date, they can create confusion when trying to follow distinct logic flow through activities.

These redundant relationships changes must be eliminated before the schedule will be ready to be included in the PMB; details will need to be coordinated with DOE-ORP Project Control. Discussion of specific requirements is provided in appendix F of this report.

> **Recommendation**: BNI must continue to review and clean up the schedule to eliminate redundant relationships.

4.8 Conclusions

The IVR Team validates the schedule as an adequate basis for the May 2006 EAC. Team concerns, identified to BNI during the review and validation process, were addressed and resolved, but significant improvements to the schedule are required to make it a more meaningful performance measurement and EVMS tool.

SECTION 5.0 - PROJECT AND PROGRAM RISK ANALYSIS

5.1 Introduction

The IVR Risk Team reviewed the WTP risk management program used by BNI in the development of the May 2006 EAC. BNI uses this program to determine magnitude of risks and suggest needed funding as contingency to cover perceived project risks. The Team review concentrated on risk identification (what are the risks), risk quantification (how big are the risks), and risk analysis (what are the risk effects to WTP cost and schedule). To perform the review, information was gathered from onsite interviews and from review of relevant documents, procedures, and reports.

This section provides general definitions and discussions corresponding to a conventional understanding of risk principles; a review of BNI risk management processes; confirmatory risk and contingency assessments; and observations with accompanying recommendations for improvement.

5.2 Methodology

The IVR Risk Team gained an understanding of the processes used by BNI for risk management. The Team then evaluated BNI's use of those risk management processes; each of the major risk processes was individually reviewed. The IVR Risk Team then performed confirmatory risk and contingency assessments based on the May 2006 EAC. IVR Risk Team findings were used to validate and evaluate BNI risk results. The technical, process, and plant design issues were outside this EAC review and specifically excluded.

The IVR Risk Team review of BNI risk management processes was performed in conformance with the Risk Management section (chapter 14) of DOE Manual 413.3-1. Detailed discussions on risk management background, definitions, terms, and methods used by the IVR Risk Team are provided in Appendix G, Risk Analysis Supplement Data, of this report.

5.3 Risk Principles

5.3.1 Risk Categories

The following discussion is provided to enhance understanding of risk management concepts:

- Known risks are a result of randomness or unpredictability. They are common in cost and schedule predictions. Examples of known risks are items such as unit prices, labor productivity, or activity durations.

- Known-Unknown risks on the other hand, refer to risk events whose occurrence is feasible (even likely) but not certain. Known-Unknown risks are

generally low likelihood and high consequence risks. Known-Unknowns may either be in-scope from the point of view of a contractor or out of scope. Examples include supply chain disruptions, labor shortages, or fiscal funding changes.

- Unknown-Unknown risks refer to those risks that are unforeseen by the project team and are, therefore, clearly out of scope. Since they have not been identified, these risks can have significant consequences for project budget and schedule. Examples include technology failure, regulatory uncertainty, unlikely economic extremes/disruptions, and management effectiveness.

One of the essential purposes of a risk management program is to provide the project team with a disciplined approach and the processes needed for early identification of Unknown-Unknown risks and to hasten their movement to the Known-Unknown category. The net result is to increase project contingency resulting from Known-Unknown risks and to reduce the potential impact of Unknown-Unknown risk events.

Currently, there are no formal provisions for evaluating contingency to cover Unknown-Unknown project risks. Historical evaluation and statistical analyses of cost growth can provide management guidance as to the need for contingency for Unknown-Unknown risks. A more detailed discussion of historical analysis of cost growth is presented in appendix G.

Figure 5-1 illustrates the relational hierarchy and project phased profiles for the three risk categories and the base cost.

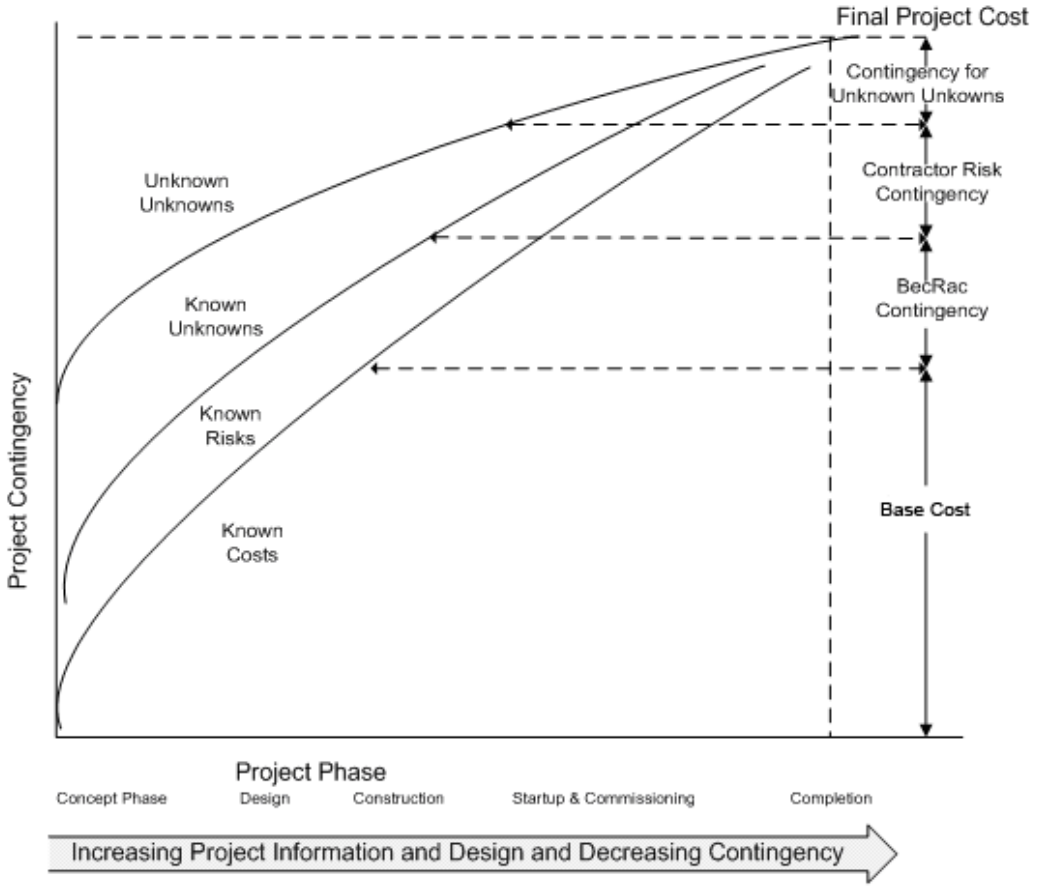


Figure 5-1. Project Phased Risk Category Profiles

5.3.2 Management Reserve and Contingency

Both DOE-ORP and BNI each carry some share of the risk for WTP. From the contract scope vantage point, changes in the scope of a project are not perceived as a cost risk to BNI, because the cost consequences of contract scope changes revert to DOE-ORP. To accommodate the distinction between BNI risk and DOE-ORP risk, different types of cost and schedule contingencies are identified. Two aspects of "contingent funds" are important. First, whether the contingency/management reserve is for "in-scope" risks or "out-of-scope" risks. Second, whether the contingency/management reserve is within the BNI budget base for the WTP project.

Management reserve contingency funds are intended to cover BNI "in-scope" risks, i.e., the risks that result from objective evaluation of EPCC scope (both Known risks and Known-Unknown risks). Management reserve must also cover those cost consequences that are a result of the schedule risk analysis process. Management reserve is funded and is included in cash flow requirements for the project.

Contingency, on the other hand, are funds intended to cover out-of-scope risks. From the BNI viewpoint, these risks are both out of scope and unfunded, therefore, they are

not included in project funding limits. Schedule consequences of such risks must also fall within the purview of contingency funds. It is important to note that while they are considered to be outside of the BNI scope, it is BNI who is tasked with identifying, quantifying, and mitigating these risk items.

5.4 BNI Risk Management Processes

BNI uses four distinct processes in their overall risk management strategy. Project execution risks are assessed using the EPCC risk process in conjunction with the EPCC "Other" process. Technical and programmatic risks are evaluated using TPRA. Finally, schedule risks are evaluated using a process built around the Pertmaster® Risk Management Software (Pertmaster) analysis program. The following sections describe each separate risk process.

BNI uses the Bechtel Risk and Contingency (BECRAC) Monte Carlo simulation analysis program and Pertmaster to evaluate the impact of Known risks. BNI uses Crystal Ball® for the TPRA and EPCC "Other" processes to evaluate Known-Unknown risks. Although there is a contingency allowance in the EAC for Unknown-Unknown risks, there is no formal process to evaluate likelihood or consequences of Unknown-Unknown risks on the WTP project. Consequently, Unknown-Unknown risks are not recognized in funding profiles nor are they included within project controlled contingency categories.

5.4.1 Engineering, Procurement, Construction, and Commissioning (BECRAC) Risk Process

5.4.1.1 Risk Assessment

The BECRAC Monte Carlo simulation analysis computational processes appear to be well developed and understood by BNI. BECRAC combines contingency values for individual terms from the EPCC and Business Services risk models to arrive at the overall management reserve for each specific facility (LAW, LAB, etc.). BECRAC analysis techniques and resulting contingency adjustment calculations are performed against project direct costs as well as overhead and hotel costs. The well-defined and relatively stable project overhead and hotel cost estimates, however, were analyzed with very high confidence ratings.

5.4.1.2 Risk Handling

The primary purpose for BECRAC analysis is to establish the contingency associated with in-scope EPCC cost risks for WTP. Currently, there is no documented mitigation procedure for use in the EPCC/BECRAC program that is similar to that used in TPRA.

5.4.2 Engineering, Procurement, Construction, and Commissioning "Other" (Crystal Ball) Risk Process

The EPCC "Other" (previously contractor technical risk or contractor risk) program is an outgrowth of the TPRA process. The thrust of the EPCC "Other" program is to define those risk items that are clearly within the BNI scope of work. Since the EPCC "Other" program was developed from TPRA, its procedures for risk planning, assessment, and handling, mimic exactly those used for TPRA. As yet, there is no separate BNI procedure or documentation for the EPCC "Other" process.

5.4.3 Technical and Programmatic Risk Assessment Process

The TPRA process focuses on technical, operational, and programmatic risks that are unfunded and out-of-scope potential program impacts. The BNI process is well documented and has appropriate procedures and computational resources. Risk identification and risk assessment are primarily carried out by BNI Area Project Management core teams. Area Project Management teams also identify appropriate risk handling strategies for individual risk events. Based on risk handling strategies, the impact of a risk event to design and construction costs is estimated and its impact to schedule is evaluated. Separate results are calculated for Technical risk, Operational risk, and Programmatic risk. Risks are also classified according to the party that has proximate control over the risk (DOE-ORP, Congress, BNI, etc.) and according to their relative likelihood of occurrence. The BNI Team issues a Risk Assessment Report that presents the results from the TPRA process.

In earlier versions of TPRA, whether a risk was within or outside of the BNI scope was a matter of some controversy. Upon DOE-ORP direction, a "contractor risk" category has been created to disentangle the question of in-scope vs. out-of-scope TPRA risks. Some risks that were previously carried in TPRA were transferred either to the EPCC "Other" category or to the EAC itself. Consequently, in the May 2006 EAC, TPRA includes only out-of-scope risks, as evident in the decrease in TPRA and corresponding increase in contingency values as compared to the December 2005 EAC. Identification and mitigation of TPRA risks may be the responsibility of BNI, or they may be the responsibility of DOE-ORP. Nonetheless, as TPRA risks, they are out of the BNI current scope of work.

5.4.4 Schedule Risk Process

The schedule risk process was developed to evaluate the impact of schedule uncertainty on the project completion date. This risk evaluation process used a commercial schedule risk program called Pertmaster. The Level 4 Critical Path Method schedule, used as a basis for Pertmaster analysis, is developed from the current WTP P3 schedule.

BNI did not use an overall integrated WTP project schedule for risk analyses. BNI believes that the schedules for individual facilities will be completed before their

integration at SCT. BNI personnel indicated that an overall integrated schedule is not considered necessary and that there are no plans to prepare an integrated schedule. The lack of an integrated project schedule limits the risk analyses that can be accomplished.

Currently, BNI is formulating a method to allocate the cost contingency funds that result from the SCT schedule risk analysis to individual WTP facilities. Currently, there is no risk mitigation procedure devised for the schedule contingency process.

5.5 Evaluation of WTP Project Risk Management

After gaining a thorough understanding of the risk assessment tools and processes used by BNI and the risk management approach being used by the BNI Project Team, the IVR Risk Team then evaluated implementation effectiveness across the WTP Project. Several observations indicated that the program is still under development and lacking full coordination between client and contractor.

5.5.1 Identification of Project Risk Drivers

Project risk drivers are not appropriately identified in the May 2006 EAC. The current BNI EPCC/BECRAC contingency is approximately 15 percent of remaining costs. The process of calculating contingency could be improved to afford BNI better information for identifying project risk drivers. More focus should be given to the key risk drivers that are identified with the EPCC/BECRAC contingency so that their effects may be reduced or mitigated.

Additionally, there appears to be some question regarding both the existence and/or the validity of project risk drivers, which quantify facility specific variables such as complexity and completion status. The PT facility has the largest contingency percentage of 23 percent and largest remaining cost, followed by HLW. Its contingency is 19 percent of the remaining costs. Other facility contingencies range from 17-20 percent of the remaining costs. It is unexpected to see the contingency so evenly distributed across all WTP facilities. Given the differences in complexities among the facilities as well as the different stages of construction, the IVR Risk Team would have expected to see a wider range on contingency amounts.

There are several very large “terms” in the BECRAC model, which would benefit from risk reassessment at lower levels of detail. The term for Field Non-Manual is $619 million, and its associated contingency is $64.8 million or 7.5 percent of the total EPCC/BECRAC contingency. Other large terms are PT Piping Labor, Management & Integration, Miscellaneous Construction Services, and Information Services and Technology. Because of their magnitude, these terms should receive a disproportionate (greater) amount of management attention due to their importance in determining contingency. Also, the five largest contingency items in BECRAC constitute a total of $195 million, or 23 percent, of overall EPCC/BECRAC contingency.

The issue of Unknown-Unknown risks is primarily a DOE-ORP issue. DOE-ORP already published guidance on appropriate contingency amounts given the complexity and degree of completion of a project. DOE-ORP and its contractors have substantial experience in first-of-a kind, new technology projects. That experience should be used to help anticipate Unknown-Unknown risks and first-of-a-kind risks.

5.5.2 Risk Management Leadership

Development and implementation of risk assessment processes appear to be a project function, which may be lacking sufficient attention and priority relative to other project functions such as engineering, procurement, and construction. One symptom observed is the lack of qualified leadership in this area. BNI needs to appoint an experienced technical risk manager retaining appropriate training and experience to enhance and integrate various BNI risk processes. Additionally, the risk manager should be responsible for keeping major risks visible to the Project Team and for leading proactive management and mitigation efforts.

Similarly, to strengthen project-wide risk management leadership, DOE-ORP needs to develop and deploy onsite expertise to evaluate the WTP risk management processes and to address issues. Such expertise can be used to more thoroughly evaluate and manage the risks that arise outside of the scope of WTP. These would include both upstream risks from the Tank Farm and downstream risks from interim storage, transportation, and the long-term repository facilities. While these issues may not change the schedule or contract sum for WTP, they could have far-reaching effects on the technical planning, design, construction, and operation of this facility. There should be more focus on the entire DOE-ORP program, rather than just focusing on WTP construction.

5.5.3 Risk Management Integration within Project Team

Individual risk processes exhibit considerable differences in their maturity and integration into other management activities. The newer risk processes (Schedule and EPCC “Other”) have not yet been formalized and integrated into day-to-day WTP project management. Given the large potential impact of technical and funding uncertainty, an integrated risk process would benefit both DOE-ORP and BNI management.

DOE-ORP should have a more proactive involvement in the BNI risk management program. If there are shortcomings in the BNI processes, DOE-ORP needs onsite expertise to discover the shortcomings and to correct them. Understanding risk processes, both management and mathematical aspects, requires staff with appropriate training and experience. An example of this would be more involvement by DOE-ORP in the TPRA program that is managed by BNI. The Team understands that DOE-ORP has added staff positions to address this issue. At the time of this report, it was not clear to the IVR Team whether this assignment would be sufficient or effective.

5.5.4 Management Reserve and Contingency Categorization and Control

The IVR Risk Team observed confusion and lack of BNI/DOE coordination regarding the initial labeling, distribution, and control of risk management funds relative to the management reserve and contingency funding categories. Clarification, as to when contingency is controlled by DOE-ORP and when it is controlled by BNI, needs to be formally established, as does the relation of annual funding restraints to TPRA contingency. The question of how "out-of-scope" schedule issues are impacted by TPRA should also be addressed.

BNI frequently misused the contingency and management reserve terms in the May 2006 EAC, which has lead to confusion during the review of risk funds. Currently, DOE-ORP and BNI use the term "contingency" to categorize EPCC, EPCC "Other," Schedule, and TPRA risk categories. This does not conform to DOE Guide 430.1-1, which establishes separate definitions for and ownership of "management reserve" and "contingency."

5.6 Confirmatory Risk and Contingency Assessments

The IVR Risk Team completed confirmatory risk and contingency assessments of the May 2006 EAC. Team findings were used to modify and update BNI risk results. Consistent with BNI's approach to risk analysis, the IVR Risk Team analysis techniques and resulting contingency adjustment calculations were all performed against project direct costs as well as overhead and hotel costs. The well-defined and relatively stable project overhead and hotel cost estimates, however, were analyzed with very high confidence ratings by both BNI and the IVR Risk Team.

5.6.1 Process Observations

Ttable 5-1 describes the main changes to WTP contingency resulting from the review. The changes are divided into two types. The first, "IVR Team Adjustments" refer to modifications to WTP contingency based on detailed analysis by the IVR Risk Team. The second type, "Provisional Adjustment" are necessary changes to contingency that require additional work to define the magnitude of the change.

Table 5-1. Changes to WTP Contingency Resulting from IVR Risk Team Review

WTP Contingency/Management Reserve	BNI May 2006 EAC	IVR Team Risk Adjustments	IVR Team Provisional Risk Adjustments	IVR Team Modified Risk Totals May 2006 EAC	Report Section
EPCC/BECRAC	**$867 M**				
Adjustment to Shared Services		$28 M			5.6.4.1
Adjustment to Piping, Electrical & Instrumentation		<$40 M>			5.6.4.1
Adjustment to Commissioning Confidence Levels		$20 M			5.6.4.1
Modification to 80th % Contingency			<$210 M>		5.6.2
Change to Model to Include Interrelationships Between Variables			$50 M		5.6.3
Comprehensive Change to BECRAC Confidence Levels			$200 M		5.6.4.1
Total EPCC/BECRAC Contingency				**$915 M**	
EPCC "Other" Contingency	**$317 M**				
Total EPCC "Other" Contingency				**$317 M**	
Schedule Risk	**$167 M**				
Changes to SCT Confidence Levels		3 months & $32 M			5.6.7.3
Comprehensive Change to Pertmaster Confidence Levels			TBD *		
Inclusion of All Near Critical Activities			TBD *		
Total Schedule Risk				**$199 M**	
DOE-ORP Contingency for Scope Options	**$300 M**			$300 M	
TOTAL EPCC CONTINGENCY	**$1,651 M**			**$1,731 M**	
TPRA Contingency Including $700 M for Unknown-Unknown risks	**$1,116 M**				
Adjustment for SCT		$250 M			5.6.6
TOTAL TPRA CONTINGENCY				**$1,366 M**	
TOTAL WTP CONTINGENCY	**$2,767 M**			**$3,097 M**	

*These changes to Schedule contingency require a more mature BNI schedule model and extensive adjustments to the Pertmaster schedule and risk variables. These values cannot be determined at this time.

5.6.2 Recommendations and Revisions to EPCC Contingency

In table 5-1, the second column (BNI May 2006 EAC) represents the BNI costs provided and used for making any cost adjustments within this study. The IVR Risk Team identified necessary changes to the risk modeling approach used to calculate the EPCC management reserve using BECRAC. Additionally, the IVR Risk Team modified the data used for EPCC contingency calculations to incorporate specific recommendations from other subject-specific teams within the IVR Team. This section of the report explains the impacts of these changes.

In the BECRAC model, BNI defines the 80th percentile confidence contingency as the sum of the individual 80th percentile confidence contingencies for each term in the BECRAC model. An 80th percentile contingency that is calculated on the entire project will be much smaller than a contingency that is calculated on individual terms.

Specifically, for the May 2006 EAC, EPCC contingency based on the entire project is only $657 million as compared to $867 million based on the BNI current method, 24 percent smaller <$210 million> than the BNI value.

The IVR Risk Team approach follows common industry practice. It is also consistent with the method used to establish the 80th percentile TPRA contingency and the 80th percentile schedule contingency. Ultimately, the method of calculating the 80th percentile contingency must be a DOE decision.

Additionally, other suggested changes to the BECRAC analysis that are discussed in the following sections will increase the contingency and make it similar to the current BNI value.

5.6.3 Dependence between Risk Variables

In the May 2006 EAC, the BNI analysis treats each variable factor in the BECRAC model as an independent variable. In earlier versions, variables were modeled to reflect their interdependencies. These dependencies have the effect of increasing the variance of the risk result; therefore, contingency will be larger for a model that contains dependencies than for a model that treats all variables as mutually independent.

It is a substantial change to the BECRAC model to incorporate interdependencies among variables. To determine whether such a change would yield large changes in contingency, the IVR Risk Team created a model with interdependencies limited to only the field non-manual and the labor pricing variables. This one change to the EPCC model resulted in a contingency increase of $31 million (for a total of $50 million as shown in table 5-1). More work is needed to fashion a model that incorporates all of the interdependencies among risk variables.

5.6.4 Changes to BECRAC Data

The IVR Risk Team, during the review of the modeling process, identified adjustments to several portions of the May 2006 EAC. These adjustments, in turn, caused changes to WTP risk models. Changes to BECRAC risk data that were initiated by the IVR Risk Team are detailed in the following sections.

5.6.4.1 BECRAC Risk Ranges

The confidence levels used in BECRAC are strongly biased toward the high confidence end of the uncertainty spectrum. Approximately 70 percent of the terms used in the four BECRAC models are identified in the high confidence or medium high confidence category. If these optimistic terms are adjusted from high to medium or more conservatively from one high to medium adjustment and one high to medium high adjustment, the results for a "typical" term with two variables (e.g., price variable and quantity variable) reveal a worst-case contingency increase of 24 percent ($317 million). The final adjustment was $200 million.

To demonstrate the potential change to WTP EPCC contingency, the IVR Risk Team made the following model revisions. Detailed information about the rationale for each change can be found in appendix G.

- **Adjustment to Shared Services**: The confidence level of quantity and price variables were adjusted downward (less confident) for all Shared Services activities. This change resulted in an increase of $28 million in contingency at the 80th percentile confidence level.

- **Adjustments to Piping, Electrical, and Instrumentation**: The net result of the two following changes is a decrease of $40 million, as shown in table 5-1.

    - Increases in the unit rates for piping, electrical, and instrumentation activities by 20 to 60 percent were made. These changes resulted in an increase to the May 2006 EAC of $157 million, described in section 3.7, Finding 1. The adjustments in unit rates resulted in an increase on the confidence levels (more confident) of the same variables. The net result was a decrease in the BECRAC 80th percentile contingency for piping, electrical, and instrumentation activities of $46.5 million.

    - Distributable craft labor and field non-manual estimate values were increased in proportion to the increase in direct labor hours, resulting in an increase of $163 million to the May 2006 EAC, described in section 3.7, Finding 1. Due to the larger, distributable, and non-manual base cost, there is a concurrent increase for distributable craft and field non-manual labor contingency of $6.5 million.

- **Adjustment to Commissioning Confidence Levels**: Comprehensive modification to confidence levels (lower confidence) for commissioning activities resulted in an increased BECRAC contingency at the 80th percentile confidence level of $20 million.

5.6.5 Changes to EPCC "Other" Data

The IVR Risk Team did not identify the need for any adjustment to the EPCC "Other" data that resulted in revisions to the EPCC other contingency value. The IVR Risk Team process-related observations are included in appendix G.

5.6.6 Changes to TPRA Data

The SCT plan anticipates using multi-skilled exempt employees for a variety of startup functions. In the EAC, the BNI plan for SCT is that non-technical employees, such as operators, radiation technicians, and maintenance workers be non-union, multi-skilled, and capable of performing more than one task. Due to a historical precedent on the Hanford site and a reasonably strong union presence in Eastern Washington, BNI may be required to utilize HAMTC union labor rather than the multi-skilled non-jurisdictional workers as envisioned. This risk represents potential cost and schedule impacts as a result of the inherent limitations, restrictions, or other inefficiencies of a HAMTC union labor workforce. The expected additional cost is $250 million. This risk was previously included in TPRA and was mistakenly removed by BNI. BNI determined a worst-case impact of $500 million and a most likely impact of $250 million. The Team recommends an adjustment to reflect the most likely impact identified by BNI. Based on validation of the BNI TPRA process, the Team recommends that this figure be used with no additional computation. While the IVR Risk Team initially considered this to be a well-defined EPCC risk item, the Team chose to present it in TPRA since it remains a contentious issue to be resolved in the later years near project completion. The IVR Risk Team process-related observations are in appendix G.

5.6.7 Changes to Schedule Risk Data

5.6.7.1 Pertmaster Model: Critical Path, Activity Selection

The Pertmaster risk analysis model of the WTP project critical path is actually five separate schedule models, one each for the major facilities plus SCT. The finish of all four primary facilities precedes the start of SCT activities.

The BNI schedule risk (Pertmaster) analysis included only a small subset (3 percent) of activities in the BNI P3 schedule. The IVR Risk Team believes that the number of activities in the Pertmaster analysis does not adequately reflect the activities that may eventually affect the project completion date. The lack of a fully integrated schedule at the time of the schedule risk assessment limits the analyses that can be accomplished.

BNI established overall schedule contingency by adding the maximum facility schedule contingency (7 months for the PT facility, last facility finish date) to the 4-month

contingency for Hot Commissioning to reach an overall contingency of 11 months. This analysis is especially crucial for the PT facility since the overall WTP schedule contingency is based on its critical paths.

5.6.7.2 Confidence Levels

BNI establishes duration risk ranges by a predetermined definition of risk levels. In total, BNI has indicated that roughly 87 percent of the activities in the schedule risk analysis will be completed in less than 120 percent of the original duration.

To test whether the BNI premise is sound, the IVR Risk Team evaluated actual schedule performance (actual duration/original duration) for activities completed in FY 05 and FY 06. This analysis shows a high variability in actual activity completion times. By this analysis, only the PT facility and the HLW facility exhibit duration risk assignments that are commensurate with FY 05/FY 06 actual performance. More than 20 percent of activities extend their durations by 50 percent or more. Clearly, the uncertainty in activity durations has greater unpredictability than the BNI risk assignments indicate.

5.6.7.3 Startup, Commissioning, and Training Duration Risks

Risk level assignment for the SCT schedule is especially striking since 96 percent of the activities were assigned risk level Medium (i.e., ±20 percent). By assigning such a high percentage of activities a risk level of Medium, BNI could be understating schedule contingency for SCT. The IVR Team SCT experts assessed the SCT activity confidence levels in the same manner as BNI.

These confidence levels were used to modify the Pertmaster SCT model and the resultant contingency for the SCT schedule was 6 months and 3 weeks; an increase of 3 months schedule contingency, with a resulting increase of hotel cost of $32 million.

5.7 Validation Results

Risk management processes used by BNI for the WTP project are acceptable. The combination of EPCC, Schedule, and TPRA risk programs cover customary risk categories. IVR Risk Team suggestions for improving the risk processes are provided in this section.

The IVR Risk Team validated the BNI Risk Analysis with observations and recommendations for improvement in section 5.8 and adjustments are presented in table 5-1. There is one finding associated with the IVR Risk Team validation.

Significant improvements have been made to the BNI risk process since the USACE independent review of the April 2005 EAC performed in 2005.

5.8 Findings

Finding 3: In the May 2006 EAC, BNI plans to use non-jurisdictional labor for non-technical employees for SCT. BNI may be required to utilize workers falling under the local union labor agreement, resulting in higher costs and schedule extensions. This risk was previously included in TPRA and was removed by BNI. BNI determined a worst-case impact of $500 million and a most likely impact of $250 million. The IVR Risk Team recommends an adjustment to reflect the most likely impact identified by BNI. Based on validation of the BNI TPRA process, the Team recommends that this figure be used with no additional computation.

> **Recommendation**: The IVR Risk Team recommends re-inclusion a $250 million addition to the May 2006 EAC TPRA contingency associated with the proposed use of non-jurisdictional labor for SCT technical support.

5.9 Observations

Observation 8: BNI contingency calculations were done on a WTP-wide basis. The project is now required to be managed as five separate projects. Given the differences in complexities among the facilities as well as the different stages of design and construction, it would be appropriate to see a wider range on contingency amounts. It appears that the same confidence levels are uniformly used for individual facilities. Approximately 70 percent of the terms used in the four BECRAC models are assigned "high" or "medium high" confidence levels. Given the complexity, size, and history of WTP, less "confident" assessments in the BECRAC variables would be expected, especially on facilities less complete and more complex.

> **Recommendation**: Update the assigned term confidence levels in the risk contingency calculations to reflect the current design, construction status, and complexity of each facility.

Observation 9: DOE-ORP and BNI staff complements are not adequate to support needed improvements to WTP risk programs; BNI has not appointed an experienced risk manager.

> **Recommendation 1**: DOE-ORP needs to develop and deploy onsite expertise to evaluate the WTP risk management processes and to address issues. The IVR Risk Team recommends that DOE-ORP implement a program that evaluates the risks that arise outside of the scope of WTP.
>
> **Recommendation 2**: DOE-ORP should have a more proactive involvement in the BNI risk management program.
>
> **Recommendation 3**: BNI needs to appoint an experienced technical risk manager. This risk manager should have the appropriate training and experience to enhance and integrate various BNI risk processes and should be

responsible for keeping major risks visible to the Project Team and for leading proactive management and mitigation efforts.

Observation 10: WTP risk processes are not integrated. The BNI risk program is comprised of individual systems that are only loosely coupled (TPRA, BECRAC, EPCC "Other," and Schedule). The fact that individual risk processes are not integrated limits WTP management's comprehensive risk understanding.

Recommendation: BNI needs to develop a more integrated risk program that will improve risk identification and quantification and allow analysis of interaction effects among cost, schedule, technical, and funding uncertainties.

Observation 11: Currently, BNI is performing TPRA risk identification and quantification; however, the TPRA contingency belongs to DOE-ORP. DOE-ORP involvement in the TPRA risk management process is insufficient and responsibility for identification, impact, and mitigation remains unclear.

Recommendation 1: In order to provide DOE-ORP an accurate appraisal of all potential TPRA risks, the risk management program must include DOE-ORP as an active oversight participant.

Recommendation 2: The TPRA process should be capable of incorporating the TPRA schedule effects into the overall schedule risk analysis and formally establish the relation of annual funding restraints to TPRA contingency.

Observation 12: One of the essential purposes of a risk management program is to provide the Project Team with a disciplined approach and the processes needed for early identification of Unknown-Unknown risks and to hasten their movement to the Known-Unknown category. DOE and its contractors have substantial experience in first-of-a kind, new technology projects, but they are not being effectively leveraged to help anticipate Unknown-Unknown risks and first-of-a-kind risks at the WTP.

Recommendation 1: The determination of contingency for Unknown-Unknown risks should be based on a formal comprehensive study by DOE-ORP.

Recommendation 2: DOE should initiate a "complex-wide" study that compares contingency as a function of complexity, design completion, new technology, etc. DOE (not the WTP Team) needs to establish a process to incorporate DOE "complex-wide" experience into the WTP risk process.

Observation 13: Currently, the WTP does not conform to DOE Guide 430.1-1 in the definition of and the use of "contingency" and "management reserve" for the development of the May 2006 EAC. Throughout the document, BNI frequently misused the contingency and management reserve terms.

Recommendation: Clarify and consistently employ contingency and management reserve terms as they relate to each of the risk categories.

Observation 14: The method used to calculate the 80th percentile contingency in BECRAC overstates required contingency. Moreover, the method used in BECRAC is not consistent with methods used in TPRA and Schedule risk to determine the 80th percentile contingency.

> **Recommendation**: Improve the process of calculating contingency to better align with methods used in TPRA, Schedule risk, and common industry practices.

Observation 15: Dependencies and correlations among related variables in BECRAC are not accounted for in the model. BECRAC treats all risk variables as if there are mutually independent, a situation that causes the 80th percentile confidence to be understated. Dependencies and correlations among related variables should be accounted for in the model.

> **Recommendation**: Revise dependencies and correlations among related variables in BECRAC.

Observation 16: The computational value of the EPCC risk process would be enhanced by using a more comprehensive Monte Carlo tool.

> **Recommendation**: Since BNI already holds a license for Crystal Ball, using a commercial Monte Carlo program would provide added functionality to the existing EPCC analysis. The added information about risk drivers provides project management with a powerful tool for managing risk.

Observation 17: BECRAC identifies "terms" that are identifiable cost elements in the cost estimate. Each term is comprised of one or more variables. Several very large "terms" exist in the BECRAC model, which result in an insufficient level of management attention being applied to these terms relative to their importance in determining contingency.

> **Recommendation**: Terms that are associated with large contingent amounts should receive extra management attention and review. BNI should consider dividing the largest cost terms into smaller, more specific terms.

5.10 Progress/Improvements since April 2005 EAC Independent Review

Significant changes have been made to the BNI risk process since the USACE independent review of the April 2005 EAC performed in 2005. Those changes have had positive effects on the overall program, though notably, the improvements have resulted in higher calculated contingencies with a greater EAC.

BECRAC analysis for the May 2006 EAC is based on four separate models resulting in smaller BECRAC models. The smaller sizes of individual models fall within the limitation of the number of terms in the BECRAC software.

By DOE-ORP directive and based on recommendations from the IVR Risk Team, the EFRT, and the ERT, many risk items that were previously in the TPRA or other contractor risk models have been moved to either the EPCC "Other" risk model or into the BECRAC model. Because of this change, ambiguity regarding which risks are in scope and which are out of scope has been clarified.

A new procedure document was developed, covering BNI project risk management that formalizes these changes, and is currently out for review. The new risk procedure will update the current November 2002 risk procedure.

The contractor technical risks process has been expanded (as EPCC "Other") to include all contractor risks that are not included in the EPCC analysis. Some items that were previously included in TPRA and risk items identified by both the IVR Team and the ERT are now included with contractor risks.

The Pertmaster model for schedule contingency analysis has been improved, since it was first used for December 2005 EAC.

5.11 Conclusion

WTP has experienced significant cost, schedule, and contingency growth during the past few years. The studies by both the Rand Corporation and DOE support the idea that large, complex, technologically innovative projects experience disproportionately large cost and schedule growth. This growth may be due to a number of factors including, the need to develop technology as well as the project size and process complexity. WTP is a large project that contains new and complex technology. Therefore, portions of the identified cost growth should not have been unexpected and are better reflected in the most recent EACs.

BNI risk management practices have improved identification and reporting of risk-related costs in the recent EACs. WTP has a better understanding of overall project uncertainty, however, as indicated in this report, further refinements as well as improved management processes are required to control costs. The two facilities with greater risk are HLW and PT due to the complexity of the technology involved and the lack of design maturity.

SECTION 6.0 - MANAGEMENT PROCESSES

6.1 Introduction

The purpose of this portion of this validation review was to evaluate the management systems, processes, and tools used by BNI and DOE-ORP. Although the IVR Team validates the May 2006 EAC, the Team uses this section to evaluate management effectiveness and its relationship to historical and potential cost and schedule growth.

The May 2006 EAC schedule indicates that the completion date for this 6-year-old contract has slipped from July 31, 2011, to August 2019, a delay of approximately 8 years. The revised cost estimate represents an increase from the original $3.965 billion estimate to $11.553 billion, excluding contractor fee, an increase of more than 191 percent. Management is considered just one of the many contributing factors to this increase.

The USACE scope of work for this effort states, “Provide recommendations where possible for improvements, which could affect cost and schedule performance, this would include a rationale for any recommendations and quantifying their impact on cost and/or schedule.”

On April 6, 2006, Chairperson, Representative David L. Hobson of the Energy and Water Development, Subcommittee of the House Appropriations Committee, requested constructive input and recommendations to improve the WTP project.

6.2 Methodology

Recognizing the critical nature of this portion of the validation review, USACE assembled a team of senior executives and recognized professionals with extensive executive management experience in energy program management, waste management, manufacturing operations, design and construction management, and nuclear facilities management in both the public and private sectors. The IVR Team benefited from direct experience at Hanford, with the government and with BNI organizations.

The IVR Management Processes Team performed a comprehensive evaluation of formal documents, including management-related correspondence, memorandums, issued orders and guidance, and industry protocols to determine the level of compliance with expected and established standards. The Team identified any potential deviations or conflicts that could detrimentally impact the WTP project. The Team also considered the results of other reviews that occurred concurrent with this IVR effort and those that concluded prior to its beginning. The IVR Management Processes Team reviewed the WTP contract to identify any areas of deficiency, conflicting objectives, or weak language preventing proper alignment of interests between stakeholders. The Team also conducted and attended meetings, discussions, and peer reviews to receive direct communication from relevant DOE-ORP and BNI personnel in an attempt to determine

any potential causal factors contributing to the increase in cost and schedule that have been experienced to date.

The IVR Management Processes Team evaluated WTP management with respect to strategic and performance management objectives and practices. The Team reviewed BNI and DOE-ORP management and support resources, staffing profiles, organizational structures, and management techniques. The effort employed peer reviews, informal discussions, and meetings with personnel assigned management responsibilities for EAC development; periodic briefings; technical position papers; and those involved in project controls. The Team also provided a comprehensive review and evaluation of all available and relevant project-related documents. The IVR Management Processes Team compared these elements relative to the Team's experience with other large, multi-organization, complex projects underway or having occurred in the public and private sectors.

6.3 WTP Estimated Cost and Schedule History

In the past 6 years, scope, cost, and schedule growth have continued on this first-of-a-kind, complex project. EAC values demonstrating this growth are presented in table 6-1.

Table 6-1. WTP Estimated Cost and Schedule History ($ in Millions)

	Offerors Proposed EAC December 2000	March 2003 EAC (Baseline)	April 2005 EAC	December 2005 EAC	May 2006 EAC
Base Cost	$3,465 M	$4,856 M	$7,294 M	$7,736 M	$8,786 M
Contingency	$500 M	$550 M	$700 M	$1,041 M	$1,651 M
TPRA[1]	$0 M	$100 M	$900 M	$1,760 M	$1,116 M
Total Cost[2]	$3,965 M	$5,506 M	$8,894 M	$10,537 M	$11,553 M
Schedule	July 2011	July 2011	July 2011	May 2017	August 2019
Design Complete	5-10%	<40%	60%	68%	68%

[1]Technical and Programmatic Risk Assessment.
[2]Costs do not include contractor fee.

The May 2006 EAC of $11.553 billion represents an increase of $7.588 billion, or 191 percent, over the original estimate (Offeror's Proposed) of $3.965 billion. The IVR Team recognizes that the WTP is a first-of-a-kind, complex project and understands the complexities involved with estimating cost and schedule. However, previous reports (provided in section 2.2.2) cite a faulty initial estimate and optimistic treatment of uncertainty and risk (as shown in table 6-1, only $500 million in Contingency and $0 in TPRA at December 2000). It is evident that design, contingency, and TPRA evolution have also occurred. The May 2006 total reflects $2.7 billion in Contingency and TPRA. Major technical, regulatory, and programmatic changes include the following:

Technical

- Design changes required to overcome unplanned technical challenges such as non-Newtonian fluid mixing, control of hydrogen in piping and ancillary vessels, and remote operability and maintainability of equipment.

- Changes to address modified seismic design criteria.

- Increases to the treatment capacity of the plant. Throughput of the HLW glass-making process was quadrupled and the capacity of the pretreatment processes was increased by 40 percent.

- Changes to address and resolve design deficiencies.

Regulatory and Programmatic

- Changes to funding streams.

- Increases to contingency and TPRA due to improved focus on and reporting of risk assessment.

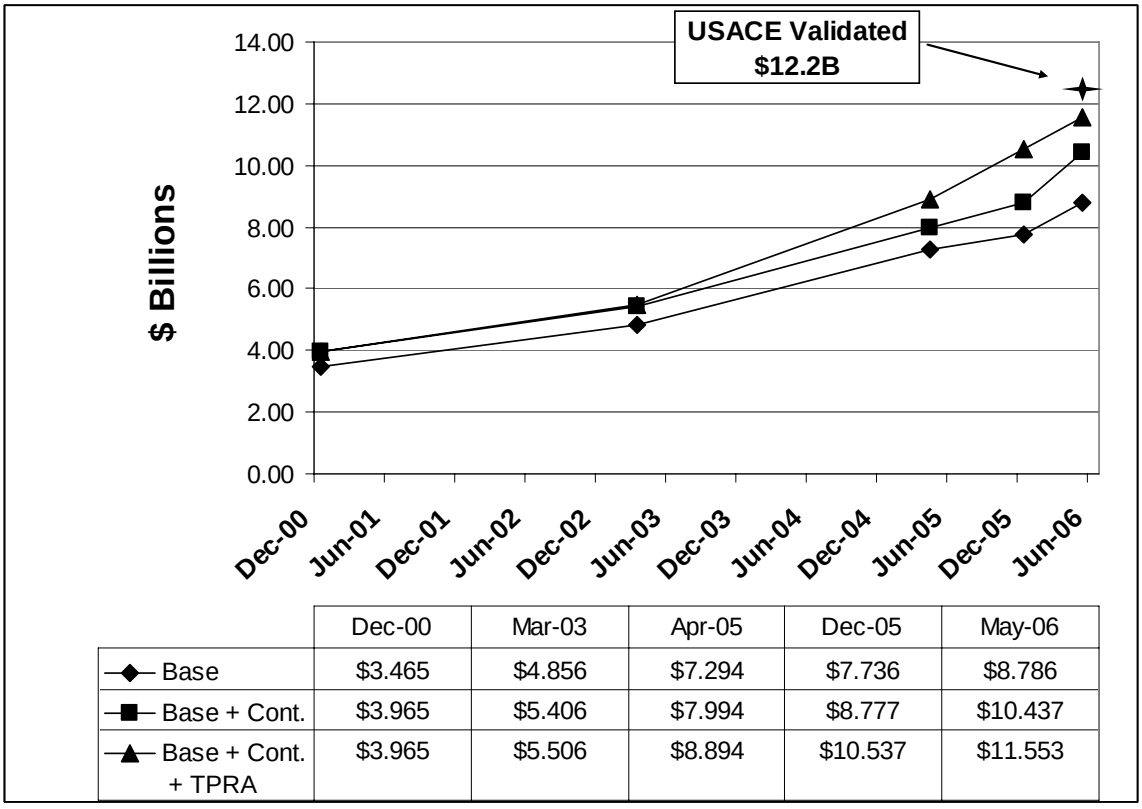
The facts that surround the increases to cost and schedule experienced on this project can be found in other reports, such as the Hanford WTP LMI After-Action Fact-Finding Review (2006). This report states, " . . . increases in estimated costs and schedule delays for the WTP project primarily result from a faulty initial estimate and the optimistic treatment of uncertainty and risk for the following: design of novel technology for a large, complex nuclear-chemical plant; quantity, procurement, and availability of physical capital; availability and productivity of qualified (professional and craft) labor; and regulatory compliance. These four factors account for approximately $2 billion in cost growth." The report further states, " . . . cost misestimation was further aggravated by conditions created by a flawed acquisition strategy and defective management approach . . . ."

The 1981 Rand Report refers to five key factors for cost growth: Scope Changes, Inflation/Escalation, Regulatory Changes, Bad Luck, and Management Practices. The report also asserts, " . . . poor project management, like the other factors, is not something that an estimator can predict, but poor scheduling, inadequate cost control, weak supervision of contractors, and so forth can plunge a project into financial ruin." In addition, the report states, "The more a plant's technology departed from previously established commercial systems, the larger would be the cost growth in estimates and the poorer would be the plant's performance."

The EAC contingency and TPRA development attempt to capture possible Scope Changes, Inflation/Escalation uncertainty, and to some degree Bad Luck. It is unclear whether they fully capture the effects of Regulatory (and funding) Changes and Management Practices related to the WTP and its historical growth. With the exception

of Management Practices, the factors that contribute to cost growth, cited by the Rand report (1981), are considered "external" and impose a culture of reaction by stakeholders. Management Practices, however, is the one internal project factor that allows for a proactive capability and can directly influence reaction to the others. Management Practices at the WTP encompass activities shared by DOE-ORP, DOE-HQ, BNI, and other external stakeholders, which may have fostered a reactionary culture and inhibited project management effectiveness, as outlined further in this section.

Figure 6-1 illustrates the USACE validated EAC of $12.2 billion (excluding potential fee and other potential incentives) in comparison to the cost history for the WTP. The USACE value demonstrates the trend for higher EAC values with each subsequent submittal.



	Dec-00	Mar-03	Apr-05	Dec-05	May-06
Base	$3.465	$4.856	$7.294	$7.736	$8.786
Base + Cont.	$3.965	$5.406	$7.994	$8.777	$10.437
Base + Cont. + TPRA	$3.965	$5.506	$8.894	$10.537	$11.553

Figure 6-1. WTP EAC Cost Curves

Individual and compounding causes for cost and schedule growth continue to be argued among the experts and speculators. However, the IVR Management Processes Team asserts that management practices, while overshadowed by other widely reported impacts (Technical, Regulatory, and Programmatic), have profound influence on the outcome of the WTP project in terms of cost, schedule, and ultimate completion.

Numerous management improvement efforts (see section 2.2.3) have been initiated by both DOE-ORP and BNI over the past months in an effort to curb these historical growth trends. DOE-ORP has also directed full application of DOE Order 413.3 including the requirement for application of a certified EVMS. The preparation, review, and certification process for EVMS is now underway. Since these initiatives are recent, measured improvements have yet to be demonstrated. This leaves concern that cost and schedule growth may continue above the USACE validated figure of $12.2 billion without near-term adoption of rigorous management and project control processes. In addition, under a constrained funding situation, any increase in cost may translate to additional schedule growth. Cost curtailment, cost avoidance, and continuous process improvement must become part of the standard operating procedures at the WTP. Several findings and observations are presented along with relevant recommendations intended to support optimization of DOE-ORP and BNI Project Team effectiveness in controlling potential cost and schedule growth.

6.4 Management Effectiveness Evaluation

The information presented in the following paragraphs is based on document research by the IVR Management Processes Team and direct communication with DOE-ORP and BNI managers and support personnel. It incorporates the subject matter expertise and direct experience of IVR Team members. It should be recognized that some of the conclusions drawn from this evaluation are supported by previously submitted reports (LMI 2006 and EFRT 2006).

6.4.1 Contract Management Considerations

The LMI report (2006) states, “While ORP project management documents were in place and approved, ORP was not fully following the project management procedures outlined in DOE Order 413.3 and DOE Manual 413.3-1. Moreover, DOE Order 413.3 requirements were intentionally left out of contract documents.” The IVR Management Processes Team believes a primary contract management problem was the establishment of weak language in the initial (and current) contract between DOE-ORP and BNI. The existing contract does not adequately enable DOE-ORP to confidently administer the project as owner and operator.

DOE Order 413.3 compliance requirements have recently been added via contract modification. In certain areas, the current contract discusses DOE expectations rather than well-defined requirements that can be enforced. Examples can be found in Section C – Contract Approach of the contract. The resulting impact is less contractual authority of the owner to enforce design, project control products, and reports.

Specific examples of inherent contract weakness utilizing phrases such as, “should,” “would,” and “expect” were discussed with DOE-ORP contracting officers and a DOE attorney, who indicated that weak verbiage is difficult to enforce under a performance-based contract. It should be emphasized that DOE-ORP drafted a more definitive contract revision (Standard 1) to strengthen their contractual position.

6.4.2 Design Authority

The contract SOW, Section C.2, Contract Approach states, “From contract award, the contractor will be the design authority, responsible for the WTP design. DOE will expect full contractor accountability for performance, cost, and schedule throughout the contract period of performance.”

The existing language establishes BNI as the “design authority” for the WTP; however, the design authority function is not adequately defined in the contract and subject to interpretation. Further, DOE-ORP is placed into a subordinate technical role when design is questioned or contested. This relationship erodes the authority that should be afforded to the owner, operator of the WTP and results in continuous disputes. The IVR Team identified a large number of outstanding scoping issues that have gone several years without contract or design resolution. This was reinforced by the EFRT report (2006) as well as numerous discussions with BNI and DOE-ORP personnel.

6.4.3 Ongoing Design Issues

After 5 years into this contract, DOE-HQ directed BNI to convene an EFRT to conduct a comprehensive review of the entire WTP process flow, focusing on throughput. After evaluation, 28 items remain as issues; 17 are major issues and 11 are potential issues. The following issues need to be resolved to provide additional assurance that the WTP will function as intended:

- The leaching/filtration process at the front end of the PT facility was identified as the WTP limiting process, which may constrain throughput to approximately one-half of project requirements.

- Other process and equipment design issues, as noted in the EFRT report (2006), include:
    - Plugging in process piping.
    - Mixing vessel erosion.
    - Inadequate design of mixing systems.
    - Design for commissioning waste vs. mission.
    - Waste feed pre-qualification capability.
    - Ill-defined process operating limits.

- Additionally, a significant change in seismic ground motion requirements remains unresolved. Progress is being made; structural design criteria have been approved and confirmatory data is being obtained. However, progress has been slow in determining scope, cost, and schedule impacts. As earlier reported by BNI, costs could increase to an estimated $700 million. Updating design calculations and performing analysis confirmation is estimated to still require more than 400,000 labor hours and additional bore holes for seismic reviews are planned.

6.4.4 Manage the Contract, Not the Contractor

In discussions with numerous DOE-ORP personnel, they acknowledge their instruction to manage the contract, not the contractor. DOE Manual 413.3-1 instructs, "It is keeping with the Department's philosophy that the role of Federal officials is to develop the overall strategy; establish requirements and performance expectations; manage the contract, not the contractor; monitor and assess performance; and proactively anticipate and resolve issues that impact project success." The interpretation by DOE-ORP personnel is that this relegates them to a position of contract administrator resulting in reluctance to challenge design authority or contractor management decisions.

Lack of definition of design authority and the interpretation of "manage the contract, not the contractor" has resulted in a degree of uncertainty at the working level with regard to interface and authority. The IVR Management Processes Team observed that resolution of some contractual and management issues are elevated to DOE-HQ rather than resolved on site. Although unconfirmed by the Team, discussions provided information that BNI will go directly to DOE-HQ on certain matters, bypassing site officials. This can undermine DOE-ORP authority in contract administration and further erodes site understanding of responsibility roles. The IVR Team recognizes that the strategy of managing the contract (not the contractor) was and continues to be a successful approach on other DOE projects, such as the Rocky Flats Environmental Technology Site. However, Rocky Flats was a decontamination and demolition project, performed and managed by a different contractor and a different DOE organization. The interpretation and/or execution of the language included in DOE Manual 413.3-1 has not been effective at the WTP project, which is new construction of a highly technical nature.

Based on interviews with DOE-ORP management and support personnel, it became apparent that ambiguity exists as to the roles, responsibilities, and authorities allowed at the working level. It is also reported that DOE-ORP has been excluded from BNI meetings, such as Engineering Progress Performance Report meetings, in spite of being the "owner" of the site and its resources with responsibility to accomplish specific objectives. The IVR Team notes that DOE-ORP lacks adequate personnel to attend all critical project oversight meetings and has observed DOE-ORP personnel leaving meetings prior to completion. The IVR Management Processes Team was advised that a Functional Requirements Assignment Matrix document does exist and is provided to all DOE-ORP staff. However, reemphasis of the document and its definitions and responsibilities appears in order on both the DOE-ORP and BNI sides.

Additional culture problems identified by the EFRT include the lack of apparent shared mission and vision between DOE-ORP and BNI. An approach that emphasizes management or administration of the contract, rather than management of the contractor, presents a challenge to several critical mission objectives, such as WTP throughput, length of mission, and preparation and use of management tools. Unless there is a clear mission statement and shared vision among partners, the owner, and the contractor could collectively impede development of an effective and shared project

strategy that is in the best interest of all stakeholders. This becomes even more critical as DOE-ORP becomes the owner responsible for operation of the plant after BNI departure. Although an appropriate contract may provide the necessary legal basis for contract oversight, it is not an effective tool for establishing common goals and objectives.

6.4.5 Disputes and Resolution

The IVR Management Processes Team found that when DOE-ORP assumes an authoritative position regarding technical changes, the prevailing BNI reaction has been to interpret this as added scope outside of the existing contract, with the intention of submitting an REA and associated adjustment to fee. The REA process is a contractual vehicle that can be used by BNI to request additional project time and cost for work or materials viewed as being outside the contract scope.

Currently, there are approximately 40 contractually unresolved scope items that are valued between $1.5 and $2 billion. In a letter to BNI from DOE-ORP dated June 21, 2006, DOE-ORP requested that BNI begin addressing items that BNI believes warrant an REA "since the May 2006 EAC will be used as the basis for establishing a baseline for the project…" At this time, no REAs have been formally submitted to DOE-ORP for review. Their associated estimated costs have been included in the May 2006 EAC, but they have not been submitted, reviewed, negotiated, or finalized, nor has their individual schedule impact been finalized. This means that the March 2003 PMB and schedule for the WTP have become significantly outdated and ineffective as a performance measurement tool. If scope, cost, and schedule changes to a contract are not negotiated in a timely manner even though the work may be proceeding, then, by definition, the contract baseline for scope, schedule, and cost will always be inadequate. Costs will continue to increase and effective project management will not be possible.

6.4.6 Delayed Decisions

Delayed decisions and redirections have caused significant cost increases and disruptive impacts to the schedule (e.g., fireproofing for structural steel, seismic criteria, and EFRT issues). Overall project impacts are approaching $1 billion. While many of these costly issues have been known since early in the project, many remain unresolved, impacting design and construction with detrimental effects to cost and schedule. Direct costs, due to rework and abandonment of prior work, in addition to support activities such as engineering review, impact the bottom line. Further, ongoing embedded project support costs, otherwise known as "hotel costs," continue to drain resources and add to the EAC at an annual rate of $100 to $180 million, as represented in table 6-6 of the May 2006 EAC.

6.4.7 Project Controls

The currently recognized cost and schedule baseline is inadequate and prevents effective utilization of a change control process. Potential REAs, schedule

inadequacies, and ongoing design evolution have rendered the previously approved March 2003 baseline obsolete. The lack of critical project control tools detrimentally impacts project outcome and has caused erosion in confidence levels of a majority of stakeholders. In consideration of the scope, cost, complexity, and duration of the WTP project, there is a need for adoption of industry-best practices and tools, such as an adequate cost estimate and fully resource-loaded Level 4 schedule. The lack of a viable EVMS, supported by an adequate cost estimate and schedule baseline, has proven costly to the project. BNI and DOE-ORP are currently working to establish a certified EVMS.

Past reported cost and performance data have been unreliable and misleading. Process flaws in reporting cost and schedule performance data into the HQ Project Assessment and Reporting System allowed for incorrect perception that the project is consistently on time and within budget. A current example is the most recent (June 2006) ORP Quarterly Performance Review, which indicates cumulative cost and schedule variance reports identify a Cost Performance Index of 1.01 and a Schedule Performance Index of 0.98. These performance factors are the result of comparing current cost and schedule performance with the May 2006 EAC, which has not been established as a PMB. It appears that the May 2006 EAC is already being used as a PMB by default.

There is lack of essential integration between management information systems that significantly impedes communication and requires manual interfaces, resulting in longer process times, additional staff, and increased likelihood of data entry and reporting errors. Multiple information systems exist on the project that require shared data, but automated interfaces are insufficient or obsolete to allow the benefits afforded by interoperability and integration.

A clear set of performance criteria must be established, rigorously managed, and continuously maintained for the WTP to be successful in the near- and long-term.

6.4.7.1 Performance Measurement Baseline

Though not tasked with validating a WTP PMB, the IVR Team recognizes that there were expectations that the May 2006 EAC could be used as a PMB. Validation of the May 2006 EAC does not constitute certification of the EAC as a PMB for the following reasons:

- The EAC does not meet PMB definition requirements:

  > "An approved integrated scope, schedule, and cost plan for the project work against which project execution is compared to measure and manage performance. Technical and quality parameters may also be included." (Project Management Institute 2004.) The baseline must capture the entire technical scope of work, consistent with contract schedules, and must have adequate resources assigned. Valid cost and

schedule data depend on developing a meaningful baseline for controlling internal performance and reporting valid contract status information to the Government. Proper maintenance of the baseline prevents performance measurement against an outdated or unauthorized plan. Project managers are responsible for ensuring the accuracy of the baseline.

- A PMB consists of defined scope, cost, and schedule linked using a common WBS.
    - The current WTP WBS and supporting control accounts are not formally established to the level required for adequate management control and progress reporting.
    - It is not possible to determine cost associated with each schedule activity in the present EAC because not all resources are loaded into the Level 4 schedule.
    - Traceability is weak throughout the current EAC. All activities/cost elements must be tied to the WBS, fully integrated, and traceable from supporting details to higher levels of the EAC.

- A PMB is required to establish a working EVMS and maintain the change control process and technical configuration control. The current EAC was not developed by applying the change control process to the March 2003 baseline at the lowest level of detail. It was the product of a (new) bottom-up estimate and presents comparison to the December 2005 estimate.

- WBS elements should be measurable such that reported performance is based on work physically completed, not money spent or hours expended. The May 2006 EAC schedule activities are not fully resource loaded, precluding actual measurement of earned value.

The review process did identify possible improvements to EAC development tools and management processes that could be used by DOE-ORP and BNI management teams to establish a suitable PMB and EVMS. These improvements are described throughout the cost, schedule, risk, and management process sections of this report.

The IVR Cost Team concluded that there is a lack of data traceability within the EAC. This demonstrates an inherent weakness in the methods needed to generate, organize, and integrate data to arrive at a useful PMB. Effective integration of data allows a timely response to cost and schedule impacts. Currently, EAC development takes approximately 5 months.

During schedule review, it was determined that the project schedule does not contain all of the labor hours and direct costs for the entire WTP. Based on discussion with BNI personnel, it is apparent that they believe they have the sophisticated software tools that interface with P3 and provide tracking, leveling, and scheduling of resources without those resources being directly loaded on the P3 activities. At the time of this EAC review, BNI does not intend to complete the resource loading of the schedule.

Projects of this magnitude and complexity rely on fully resource-loaded Level 3 and 4 schedules. However, the WTP project has not been afforded the benefit of this tool by BNI. BNI is currently working on correcting the Level 3 schedule as it is presented for management reporting.

6.4.7.2 Earned Value Management System

The IVR Management Processes Team extracted definitions and principles, as shown below, from the DOE Earned Value Management Application Guide.

EVMS Definitions

> "Earned Value Management - Earned Value Management is a methodology that allows both Government and Contractor Program Managers to have visibility into cost, schedule, and technical progress on their contracts to measure and manage performance. ANSI/EIA 748, Earned Value Management System, contains the industry guidelines, which establish the framework within which an adequate integrated cost, schedule, and technical performance management system will be effective.
>
> "Earned Value Management System is the integrated set of processes, which implements ANSI/EIA 748. In its simplest form, EVMS can be implemented without software. Software simply enhances productivity, allows the implementation of EVMS more economically, and facilitates managing complex projects. EVMS is not software.
>
> "Earned Value is the budgeted value of the work actually accomplished. When compared to the planned (Scheduled) work and to the actual cost of that work, performance and progress can be determined."

Fundamental Principals of Earned Value Management

Earned Value Management, originating in industry, was adopted and further developed by the Department of Defense and spread throughout the U.S. Government, industry, and other countries, because the management concept embodied fundamentally sound principles for managing project and program performance. These principles are:

- All work is planned to completion.
- Work is broken down into finite product-oriented components that can be assigned to a responsible organization.
- Scope, schedule, and cost objectives are integrated into a plan by which progress can be measured.
- Actual costs are recorded.

- Performance is objectively measured.
- Variances and deviations are analyzed, impacts are forecasted, and estimates at completion are based on actual performance to date.
- Changes to the PMB are controlled.
- Earned value information is employed in the organization's management processes.

In spite of numerous documents discussing the need, the WTP project, which is approximately 6 years old, does not have a viable EVMS. The lack of an adequate schedule/cost baseline is a root cause for this deficiency. It should be emphasized that that DOE-ORP and BNI are working toward establishment of a certified EVMS with a DCMA certification visit scheduled in November 2006. However, at the present time, certified and formal earned value information is not employed as a part of DOE-ORP and BNI management processes for the WTP project.

Having a sound project execution plan, as well as a certified EVMS that is proactively managed, becomes more critical given the additional stipulations required by Congress. House Resolution 2419, of the Energy and Water Development Appropriations Act, 2006, requires that each of the five projects (facilities) be tracked separately with separate funding accounts and "The Department may transfer up to $5,000,000 within accounts, and between accounts...once during the fiscal year." Any need for additional funds would require a formal reprogramming request to Congress before transfer is made.

6.4.7.3 Change Control

Successful programs typically employ a structured and effective change control process that addresses both cost and schedule. BNI has a proven Trend Program that addresses cost and schedule, but BNI routinely excludes schedule impact considerations. The WTP change control program has struggled with large technical impacts, such as pulse jet mixers and the revised seismic criteria. BNI was unable to adequately address the technical, cost, and schedule impacts in a timely manner, primarily due to the lack of technical scope development and partially due to the lack of integration between a cumbersome cost estimating system and schedule systems utilized throughout the WTP. Once these significant cost impacts were determined, it became clear that there was insufficient contingency to support all necessary changes. As of November 2004, due to the contingency shortfall, DOE-HQ directed that DOE-ORP could no longer approve Trends. This, in effect, removed DOE-ORP management and control of the Trend Program and allowed BNI to continue to process Trends without considering DOE-ORP disposition.

After November 2004, many trends were managed per the BNI Trend procedure without adequate consideration of schedule impact and DOE-ORP authority and/or

co-management. Neither BNI nor DOE-ORP followed up on addressing schedule slippage in a timely manner, which compounds the problem as related to a PMB.

Presently, as the Trend process continues without DOE-ORP participation, scope arguments continue to increase the potential backlog of REAs. While there are approximately 40 potential REAs valued over $1 billion, there appears to be an inadequate BNI urgency to resolve the issues technically and contractually through the REA process. The IVR Management Processes Team recognizes that scope issues exist in various stages of definition such that not all are adequately developed for submission and resolution. The result of this practice is that the "site recognized" March 2003 PMB continues to become further outdated and irrelevant. Without a formal change control process recognizing all impacts from Trends, DOE attempted to resolve the changes through subsequent EACs.

As of August 7, 2006, DOE-ORP redeveloped their BCC process in an effort to regain control of these concerns based on the five separately funded facilities. The BCC does afford consideration for schedule as well as cost.

6.4.8 Contingency

Ownership and effective management of contingency remain in question. Per contract, all of the contingency was jointly managed by BNI and DOE-ORP. The IVR Management Processes Team believes that stronger Government control of project funds is essential to DOE-ORP authority. Sole ownership of project contingency by DOE-ORP better supports that authority. It will effect better communications between DOE-ORP and BNI as they must jointly accelerate decisions with regard to scope, cost, and schedule. Note that DOE-ORP has begun working this issue regarding disposition of contingency funds in the proposed contract revision (Standard 1). However, the issue remains unresolved until contract negotiations are formalized.

6.4.9 Quality Assurance

BNI has a quality problem as a result of a number of factors that are within and outside of their direct control. Previous reports point to a lack of qualified nuclear manufacturers and vendors, as well as experienced resources. BNI has also reported that trends over the last several quarters show a decrease in quality performance within their own team. BNI publishes a quarterly report on project quality. The last report dated November 29, 2005, (Change Control Number: 130831) states the following: "Overall, the processes designed to oversee quality performance are in place and functioning, and the project is successfully identifying, documenting and correcting problems. The trend over the last seven quarters, however, is deteriorating. Each of the three organizations, Engineering, Procurement, and Construction, has contributed to this decline."

The IVR Management Processes Team reviewed safety statistics for the project and the Occupational Safety and Health Administration Recordable and Lost Workday

Case Rates. Recognizing that BNI has already begun implementing improvement initiatives, emphasis on quality and safety must be maintained.

6.4.10 Value Engineering

BNI has used several programs in the past to study and reduce project costs, such as Optimization Studies, Total Installed and Operating Costs, and the Requirements Implementation Assessment Team. However, these processes are no longer in use. Historically and currently, Six Sigma is a process improvement tool that is nationally recognized and remains in use at the WTP site. These processes have resulted in measured cost savings and cost avoidance. The consensus regarding a structured Value Engineering (VE) process is that the best benefits would have been realized early on in the project development phase. With an approximate 70 percent design completion and a 30 percent construction completion, there is less expectation for realized benefits.

DOE-ORP has not emphasized a formal VE process to date, but the requirement to implement and include DOE Order 413.3 now places greater emphasis on VE as a formalized process. BNI notes that the VE is currently considered under the umbrella of Six Sigma and indicates VE will receive greater attention, but in a way that recognizes the project with its current maturity. Even with the current maturity, the IVR Team supports VE with added emphasis since the project ETC base cost is still approximately $6.36 billion.

The IVR Team's concern is that on a project of this size and remaining costs, VE should be more visible. Cost avoidance and diligent adoption of industry best practices, such as life-cycle cost studies and business case analyses of alternatives, should be supported, implemented, and reinforced wherever practical. Further, those studies should take a holistic approach that considers not just BNI scope, but includes the Tank Farm and WTP operations after BNI work is complete.

6.4.11 Resource Considerations

6.4.11.1 BNI Workforce Resources

Out-year staffing is a consistently identified concern. The ability of BNI to continually provide best-in-class process engineers, adequate skilled construction workers, and trained startup engineers and operators presents human resource issues that must be addressed. Industry information suggests that the experienced nuclear workforce is approaching retirement age and that competition for qualified personnel will place additional demands on competing projects, including the WTP. For example, the British Nuclear Group is hiring 300 new staffers and possibly another 400 more in its efforts to cleanup hazardous wastes at the Sellafield Processing Complex. Other examples include decommissioning of numerous Magnox gas-cooled reactors in the United Kingdom. Any resource strategy developed must consider competing projects that have

begun or are being considered throughout the duration of this project and subsequent operations.

6.4.11.2 DOE-ORP Workforce Resources

The Team considers the CPIF contract structure as placing the greatest cost risk upon the Government. DOE-ORP receives approximately two invoices per month valued at approximately $30+ million each. This averages well over $2 million in expenditures per day. DOE-ORP is required to review and approve those invoices within 7 days. Based upon the Government's risk and the substantial costs involved, the Team expected to see a more robust and active DOE-ORP oversight that monitors and scrutinizes BNI efforts, products, and funding expenditures.

The IVR Management Processes Team reviewed BNI products and processes and the DOE-ORP organizational structure and staff. The Team concluded that greater emphasis is needed in certain project control areas to strengthen DOE-ORP project oversight. DOE-ORP would benefit from an assessment of the current project control environment, including a review of existing staff skill-mix qualifications, motivation levels, and size. A retraining and/or reemphasis on management expectations, as well as increases in the size of DOE-ORP workforce, should provide necessary empowerment within warranting authority. It is noted that DOE-ORP has already begun adding and making adjustments to their organization structure during this review period. At the time of this report, greater DOE-ORP emphasis is recommended for the following:

- Detailed and confident invoice review, verification, and approvals. This would include greater coordination between Contracting and Defense Contract Audit Agency regarding review and verification of invoice documents, contractor completions, markups, backup support documents and costs, subcontracts, materials, and fabrications.

- BNI's subcontract procurement processes, especially BNI sole source and large subcontractor procurements.

- Joint resolution of apparent growing backlog of project scope disputes as presented by both DOE-ORP and BNI. These disputes can lead to REAs, affecting fee and contractual relationships.

- BNI Project Control deliverables for cost, resource-loaded schedule, PMB, EVMS, and incremental reporting documents. The problematic progress and products continue into the sixth contract year per added DOE Order 413.3 compliance. The IVR Team's validation review supports this as discussed in the previous sections.

- Personnel overseeing risk and contingency development.

- Value engineering, cost avoidance, and life-cycle cost analyses that include the Tank Farm Contractor where necessary.

6.5 Findings

The IVR Management Processes Team recommends consideration be given to the following proposed recommendations for improvement. These recommendations have been developed to facilitate near-term adherence to established project management processes as well as a "can do" culture change. Implementation is imperative to avoid potential cost and schedule growth.

Finding 4: The current WTP contract established between BNI and DOE-ORP does not provide for optimum management of the project at the site. Weak language and lack of clear contract definitions results in ambiguity of contractual roles and responsibilities. The IVR Team notes that DOE-ORP is currently pursuing contract revisions.

> **Recommendation 1**: The proposed contract changes should be reviewed and approved by DOE-ORP counsel and DOE-HQ prior to implementation.
>
> **Recommendation 2**: The IVR Team recommends that the revised contract between BNI and DOE-ORP be implemented as soon as possible to enable DOE-ORP to effectively manage and clearly articulate required contractor milestones, desired timely achievements, and any appropriate incentives and penalties.
>
> **Recommendation 3**: Responsibility assignment matrices and support details must then be communicated at various levels of the DOE-ORP and BNI organizations.

Finding 5: The baseline (technical scope, cost, and schedule) has not been adequately established.

> **Recommendation 1**: All design studies and decisions need to be aggressively pursued and all potential REAs resolved.
>
> **Recommendation 2**: Establish a disciplined process for evaluating and dispositioning all potential future scope changes. This process must be adhered to by representative members from DOE-ORP, BNI, and other relevant stakeholders. Decisions must be timely with adherence to established processes and procedures with accountability for undesired action or inaction.

Finding 6: The WTP project lacks an effective change control process.

> **Recommendation 1**: The IVR Team recommends all changes and potential disputed issues be resolved within a reasonable timeframe, based on an established process and implemented on both sides (Government

and contractor). The IVR Team recognizes that the revised Baseline Change Control process, dated August 7, 2006, attempts to remedy this situation.

Recommendation 2: DOE-ORP should be recognized as an early partner in notifications from BNI concerning potential cost and schedule impacts.

Recommendation 3: As the owner and operator, DOE-ORP must be the recognized contracting authority and held accountable and responsible for timely disposition of potential project impacts and disruptions, including notification to DOE-HQ and completion of necessary action items.

Finding 7: WTP project performance is not being actively managed with an effective EVMS. After 5 years, Unilateral Modification No. 55, December 2005, resulted in the requirement for an EVMS. Earned Value Management is a methodology that allows both Government and Contractor Program Managers to have visibility into cost, schedule, and technical progress on their contract to measure and manage performance. An actively utilized EVMS is critical in developing project strategy and execution on a fiscal year basis that supports funding of the five separate projects and their respective contingencies.

Recommendation: The IVR Team recommends a certified EVMS be implemented for use on the WTP project as quickly as possible. That effort must actively include DOE-ORP involvement, since the successful adoption and compliance with the methodology is critical to project. The IVR Team recognizes that this EVMS is scheduled for DCMA certification review in November 2006 with a certification objective by May 2007.

Finding 8: DOE-ORP needs a stronger position with regard to ownership and management of all contingency.

Recommendation: The IVR Team recommends establishing DOE-ORP ownership of all contingency. Ownership and management of all contingency establishes DOE-ORP with contract control authority. This also ensures that BNI and DOE-ORP are actively monitoring trends, costs, scope, and schedule to fund appropriate changes. The IVR Team recognizes that DOE-ORP has begun pursuing resolution of this concern within the revised Standard 1 of Section C of the proposed WTP contract. At the time of this report, this concern remains unresolved.

6.6 Observations

Observation 18: Currently, the WTP does not have an effective cost reduction program.

Recommendation 1: As the cost and schedule of a program or project continue to grow at an unexpected pace, project management has the obligation to consider (path-forward) alternatives with an objective to stop this growth, reduce

costs, and shorten schedule. BNI and DOE-ORP must emphasize the need for a strong and comprehensive cost reduction program to optimize project expenditures and the schedule.

Recommendation 2: DOE-ORP should consider cost avoidance and diligent adoption of industry best practices, such as life-cycle cost studies and business case analyses of alternatives, which should be supported, implemented, and reinforced wherever practical. Further, those studies should take a holistic approach that considers not just BNI scope, but includes the Tank Farm and WTP operations after BNI work is complete.

Observation 19: The Government assumes the risk on this CPIF WTP contract, therefore, should invest adequate resources to protect the Government's interests. DOE-ORP appears to be proceeding in a reasonable direction in organizational restructuring including the hiring of more Contracting personnel as authorized by DOE-HQ. DOE-ORP is also pursuing added Project Control and Project Management personnel, which should provide better direct support to the Federal Project Director. DOE-ORP is also developing contract changes that strengthen the DOE-Government authority. DOE-ORP uses some contracted labor in support of contract administration. However, the contracted labor does not carry the same level of authority as compared to DOE-ORP staff. During this IVR and interviews, certain areas were recognized as needing further oversight emphasis beyond the staff restructuring mentioned above.

Recommendation: As time progresses, DOE-ORP must continue to assess needs and strengthen and empower staff in areas that enable adequate contract and contractor oversight for a project of this magnitude and risk. DOE-ORP should continue progress in attaining the correct resource mix of managers and support staff that allows efficient and effective project oversight. A larger presence of DOE-ORP support staff with the requisite qualifications should allow for earlier identification of potential performance, cost, and/or schedule deviances. Any personnel identified to have less than desired qualification and/or motivation levels should be adequately trained or reassigned to lower-level responsibilities for the benefit of the project. The list below represents areas that require strong DOE-ORP involvement, support, and oversight:

- Contract Management:
    - Contract adjustments and enforcement.
    - Scope dispute evaluations and resolutions.
    - Subcontractor procurement including pre- and post-negotiations.
    - Invoice processing and direct cost verification.
    - Share in Defense Contract Audit Agency audits and reviews.
- Programs and Projects Division:
    - Cost estimates and technical analyses for contract modifications.

- o All contractor cost and pricing data.
- o Trend and change control adjustments.
- o Detailed EAC QA reviews (cost, schedule, and risk).
- o Design and construction productivity and unit rates.
- o Resource-loaded schedules.
- o Risk and contingency management.
- o EVMS certification and PMB monitoring.
- o Life-cycle cost studies including Tank Farm and plant operations.

Observation 20: Industry information suggests that the experienced nuclear workforce is approaching retirement age and that competition for qualified personnel will place additional demands on competing projects, including the WTP.

Recommendation: Any resource strategy developed must consider competing projects that have begun or are being considered throughout the duration of this project and subsequent operations. Further, current practices allow a 4-day, 10-hour per day, workweek at the WTP project. In an effort to reduce costs and schedule overall, as well as attract additional qualified personnel, WTP decision makers should perform a business case analysis on the option of an additional (second) shift and/or field overtime. The IVR Management Processes Team recognizes that the initial impact to the yearly WTP budget would be an increase, perceived by some to be cost prohibitive, but also suggest that the positive impacts overall could amount to a reduction of approximately 3 years and a savings of $1 to $1.5 billion. Accelerating the schedule to achieve milestones and accomplish objectives earlier would be supporting factors to this analysis.

6.7 Life Cycle and Contract Administration Alternative Analysis Recommendations

The following list should be considered further by the DOE-ORP managers and decision makers to improve their success in the execution of the WTP contract and successful treatment of the tank wastes. The benefits and impacts of these alternatives should be evaluated in a business case analysis, which includes the information most relevant to the current project status and technical, programmatic, and regulatory environments. The IVR Management Processes Team recognizes that some of the alternatives presented may not be currently politically acceptable. However, the significant cost and schedule growth experienced to date warrants DOE reconsideration.

6.7.1 Earlier Treatment of Tank Waste

- Consider a priority focus on the startup of the WTP LAW facility using tank waste that does not require pretreatment or can be readily retrieved and treated. Initiate operations of the LAW vitrification facility before 2012. This approach would provide the Hanford complex with a production vitrification facility at an earlier date compared to the projected date in the May 2006 EAC. It would verify operation and maintenance for one of the critical WTP

facilities and provide increased confidence and credibility with Congress and the public. In addition, this early LAW commissioning initiative would re-energize the WTP project, which appears to be languishing due to the prolonged schedule. The Team notes that this is being analyzed through a joint study by BNI and CHG, the Tank Farm contractor, and is due to be completed by the end of July 2006.

- While the startup of the LAW facility is proceeding, stop construction on the remaining facilities, except those required to operate the LAW facility, and complete design for the PT and HLW facilities. This approach would allow accomplishment of final construction efforts without significant design changes. The IVR Team has been informed that this is being discussed with Congressional staff as part of the FY 07 budget deliberations. DOE is proposing to defer construction of the PT and HLW facilities until FY 08 to permit resolution of seismic issues, resolution of the issues raised by the EFRT, and allow for additional maturing of the overall WTP design.

- DOE and the Tank Farm contractor have begun efforts for design and construction of Transuranic and supplemental LAW treatment facilities. Operation of these facilities will allow some treatment and disposal of Hanford tank wastes to occur years earlier than if processed through the WTP. The treatment of LAW in the Transuranic pretreatment and packaging facilities should be considered. These approaches (some of which are part of the baseline) will reduce WTP costs and life-cycle costs by eliminating the need for a higher capacity WTP and reduce the durational need of the WTP. The Transuranic treatment project provides additional value by treating waste from single shell tanks without placing any volume burden on limited double shell tank space. Note: A pilot-plant bulk vitrification facility is currently in design and procurement phase to treat waste from tank S-109. This facility will validate throughput and final waste performance of the vitrified product. It is termed the Demonstration Bulk Vitrification System. The concurrent effort should be continued.

6.7.2 Cost Reduction Initiatives

In addition to the construction initiatives identified above, the following should reduce life-cycle costs for the tank waste treatment mission.

- As a result of the existing BNI contract, DOE will have two analytical laboratories in the 200 area of the Hanford site to analyze highly radioactive samples: the WTP LAB and the 222S facility. The 222S facility is greater that 50 years old and does not have the throughput to support the WTP project. When the new WTP LAB becomes operational, DOE should consider shutting down the 222S laboratory and combine the functions of both. Any modifications to receive tank waste samples from the Tank Farm should be included in the WTP LAB.

- The WTP has excess liquid evaporation capability in the currently planned evaporation equipment. When sufficient tank waste is retrieved and treated, and single shell tank retrieval is completed, the evaporation operations for both tank farms, conducted in the 242-A Evaporator and WTP, could be combined in the WTP.

- The design of the WTP is complex, particularly the PT facility. In addition, a significant number of design features have been added to the design based upon safety. These design features appear to have been driven by the Defense Nuclear Facility Safety Board and conservative safely evaluations. When compared to previous successful DOE radiochemical processing operations (e.g., Plutonium Uranium Extraction Plant and B-Plant/Waste Encapsulation and Storage Facility) at Hanford, these designs are complex and may be difficult and costly to operate directly impacting the waste treatment duration. The potential to remove conservatism in the safety basis, corresponding complication, and cost of the WTP design should be continually evaluated, challenged, and corresponding changes made.

6.7.3 Effective Transition of the WTP Following Completion of the BNI Contract

Currently no clear strategy exists for the effective transition of the WTP facility to the long-term WTP operator following completion of the WTP contract. BNI does not appear to have a vested interest in DOE's successful transition of the WTP into operations. Some potential alternatives that should be considered include:

- Assignment of a management and operations (M&O) to the current WTP project, under contract to the DOE. This M&O contractor would support the commissioning of the WTP and become qualified to operate the WTP following completion of the WTP contract. This M&O contractor could be a new contractor, the Tank Farm contractor, or BNI's commissioning contractor if assigned to DOE.

- Change the BNI contract to a "design build contract" and provide an M&O to accept, test, commission, and eventually operate the WTP. Use funds in the WTP baseline to pay for the initial phase of this M&O contract.